

RESEARCH ARTICLE

Analyzing Asymmetries and Praxis in aDNA Research: A Bioanthropological Critique

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Argüelles, Fuentes, and Yáñez Asymmetries and Praxis in aDNA Research

ABSTRACT Recent developments in molecular-biology-oriented studies regarding ancient DNA (aDNA) from human remains have brought into the contemporary discussions within archaeologists, bioanthropologists, and geneticists a set of disputes, tensions, and collaborations that need to be analyzed in practical and epistemological terms. We emphasize the relevance that techno-scientific collaborations have in this context focused mainly on human evolution and the peopling of the world. These international academic collaborations constitute an ecology in which aDNA studies are currently being worked out. An *ecosystem* that reproduces the geo-political-economic asymmetries within science, and more specifically in aDNA research, which in turn opens the possibility for thinking from an ethical and epistemological perspective about the economic and power differentials and imbalances of these asymmetric relationships. We argue for building a critical conceptual tool kit in order to tackle the problematics emerging from such investigations. We propose and define three core concepts: *academic sovereignty*, *sustainability*, and *intermediary*. Additionally, we offer the term *academic vulnerability* as a consequence of cultural vulnerability. The frame we offer here provides a structure to interrogate the dynamics of vulnerabilities in the current context of scientific praxis within aDNA research

and illustrate the interplay between hegemonic science and the heritage of developing countries. [*biological anthropology, ancient DNA, ethics, sovereignty, sustainability*]

RESUMEN Los desarrollos científicos recientes orientados desde la biología molecular al estudio del ADN antiguo (ADNa) de restos humanos han generado entre arqueólogos, antropólogos biológicos y genetistas un conjunto de disputas, tensiones y colaboraciones que deben analizarse en términos epistemológicos y de prácticas científicas. Aquí destacamos la relevancia que tienen las colaboraciones tecno-científicas centradas principalmente en la evolución humana y la dispersión de la especie a lo largo del planeta. Estas colaboraciones académicas internacionales constituyen una ecología en la que actualmente se están desarrollando los estudios de ADN. Un ecosistema que reproduce las asimetrías geopolítico-económicas dentro de la ciencia, y más concretamente en la investigación con ADNa; lo que a su vez abre la posibilidad de reflexionar sobre aspectos éticos y epistémicos asociados a los desequilibrios e inequidades de poder y económicas que caracterizan a estas relaciones asimétricas. Nosotros remarcamos la necesidad de considerar un conjunto de herramientas conceptuales para abordar críticamente los problemas que emergen de este tipo de interacciones académicas. Proponemos y definimos tres conceptos centrales para esta tarea: *soberanía* y *sostenibilidad académicas*, por un lado, e *intermediario*, por el otro. Además, reflexionamos en torno al término ‘vulnerabilidad académica’ como una consecuencia de la vulnerabilidad cultural. El marco que ofrecemos aquí aporta una estructura para cuestionar la dinámica de las vulnerabilidades en el contexto actual de la *praxis* científica dentro de la investigación con ADNa. Con lo que pretendemos dar luz sobre la tensa interacción que existe actualmente

entre la ciencia hegemónica y el patrimonio de los países en vías de desarrollo.

[*antropología biológica, ADN antiguo, ética, soberanía, sostenibilidad*]

INTRODUCTION

The recent explosion of ancient DNA (aDNA) studies has spurred a heated debate on the contribution that molecular-biology-oriented practices might make to solving long-standing questions in archaeology, biological anthropology, and other anthropological research areas (Bolnick et al. 2007; Gokcumen and Frachetti 2020; Kemp et al. 2007; Leonardi et al. 2017; O'Rourke and Raff 2010; Reich 2018). Accepted hypotheses pertaining to patterns of ancestry and the relationship between culturally and biologically diverse human populations in the present and trajectories of migration of earlier *Homo sapiens* populations have been recently, and importantly, affected by genomic-bioinformatic analyses drawn from key samples from the archaeological past in different regions of the world (Barquera et al. 2020; Fu et al. 2016; Haak et al. 2015; Lipson et al. 2020; Nakatsuka et al. 2020; Olalde et al. 2019; Patterson et al. 2012; Racimo et al. 2020; Yu et al. 2020). This recent prominence of aDNA in restructuring visions, and versions, of the past does not necessarily entail that “the science of aDNA” is somehow epistemically privileged over other archaeological and bioanthropological analyses. However, there is a sense of significance and “realness” surrounding assertions derived from aDNA studies that give them “scientific” weight, and this is not exclusively drawn from the actions of the community of aDNA researchers. DNA, regardless of what form or type it is, carries with it an assumed explanatory significance that may indeed be hitting “above its weight class”—in terms of essentialist and materialist biologized explanations of what and why things are (Fox-Keller

2000; Lewontin 2000; Marks 2013). In fact, one might go so far as to suggest we are in the midst of an aDNA frenzy.

Explicit problematizations of the ethical, epistemological, and/or geopolitical consequences of this “aDNA frenzy” have emerged in nonacademic periodicals (e.g., *NYT Magazine*; Lewis-Kraus 2019) as well as in specialized publications (e.g., *SAA Archaeological Record*, January and March 2019; Benn Torres 2016; Claw et al. 2018; Linderholm 2018; Nieves-Colón et al. 2020).ⁱ Considering the subject matters raised by these discussions, it seems timely to call for a transnational critical assessment of aDNA-based knowledge production in contemporary bioarchaeology and biological anthropology.

Here, we focus on the particular ecosystem of aDNA research as seen from the perspective not of the main laboratories or funding agencies but rather from the vista of scientists on the periphery of power but centrally located at the source of the data. We are aware that there is an increasingly substantial amount of aDNA research beyond that of the “big laboratories”—in many cases, originated precisely in peripheral scientific contexts we will be focusing on here. However, our goal in this article is not to focus on these emerging sites but rather to point out a particular set of problematic practices taking place in the very core of the aDNA research ecosystem. We do not imply that “big laboratories” and funding agencies are the only substantive forces driving the scientific inquiry made possible through aDNA extraction and sequencing, but we do emphasize the power imbalances that are recurrent in this context, and that these set of practices tend to reproduce inequities and asymmetries. In sum, our goal is to continue, and add to, the emerging project of pushing epistemological and ethical engagement with aDNA research, already underway in the

Summer Internship for Indigenous Peoples in Genomics (SING) (e.g., Claw et al. 2018), for example, and with many aDNA project participants across the globe.

aDNA RESEARCH IN CONTEXT

Over the past three decades, the uptick in the ability to extract DNA samples from bones that are many millennia old and the radical advances in the ability to amplify those sequences and analyze them has added substantially to our datasets on the human past, especially in regard to the complex movements, migrations, and demographic dynamics of the terminal Pleistocene and the Holocene (e.g., Moreno-Mayar et al. 2018; Nakatsuka et al. 2020; Narasimhan et al. 2019; Raghavan et al. 2015; Reich 2018). aDNA analyses have also forced substantive revision of our understanding of what constitutes *Homo sapiens* (genomically), reinforced the reality that genetic diversity is not only a contemporary phenomenon, and revealed that many assumptions about phyletic histories of Pleistocene *Homo* likely overstated boundaries and distinctions between populations and taxa in our genus (Hawks 2013; Reich et al. 2012). In short, aDNA research has revolutionized the tool kit and analyses of the human story.

However, this increased technological and analytic capacity has not been separate from the problematic histories and practices in the fields of human evolution, biological anthropology, and archaeology and may have even amplified colonialist, discriminatory, and nepotistic practices (Bardill et al. 2018; Bolnick 2016; Cortez et al. 2021; Fox and Hawks 2019; Wagner et al. 2020). The problematic aspects of aDNA research are centered on the use and abuse of samples; ethical, moral, and legal obligations; formal recognition of and consultation with all stakeholders; respect for diverse cultural considerations; engagement of local communities in research; support of local capabilities/capacities;

coauthorship and copresentation; and plans for long-term responsibility and stewardship with the descendent, affiliated, or stakeholder communities (Bardill et al. 2018; Di Fabio Rocca et al. 2021; Wagner et al. 2020; see also Urassa et al. 2021).

For example, in a review of a specific case study related to the use and abuse of the aDNA of ancestral Puebloan peoples from Chaco Canyon, North America, Cortez et al. (2021) conclude that lack of engagement, both active and passive, on the part of the non-Indigenous scientists and research institutions with the Indigenous stakeholders resulted in a classic example of “vampire science” of aDNA (Garrison 2013). Cortez et al. (2021) demonstrate that there is little reason to believe legal guidance or institutional review will be sufficient to guide truly ethical and equitable aDNA research, and thus it is up to the overall community of researchers, research institutions, and Indigenous and other descendant/stakeholder groups to work together to develop new forms of practice. Cortez et al. effectively argue that a legitimate science of aDNA must involve full participation by Indigenous stakeholders, and that without such endeavors, there will be no ethical revolution in aDNA research.

We agree with Cortez et al. and extend their call to include the contexts wherein North American and European centers, and individuals, of institutional aDNA hegemony engage (or don't) with scientists and stakeholders, Indigenous and other, who are on the periphery of power but are centrally located at the source of the “data” and sites being sought. Take, for example, the recent overview of sixty-eight aDNA studies (published between 1994 and 2018) involving samples from South America. Di Fabio Rocca et al. (2021) found that 44 percent of the publications included no information on the permits granted for analysis and 49 percent had no information on the custody of the human remains. In 24 percent of the articles where no direct reference to permits was made, there

was the statement that “local” museums, institutions, and/or researchers “provided” or “facilitated” the samples. Finally, only 7 percent of the articles provided any in-depth evidence of a collaborative approach, 79 percent were published in the English language, and 71 percent were published in journals edited outside of South America. This is the context with which we engage in this article.

aDNA RESEARCH IS A GEOPOLITICAL CONTEXT

Our leading assumption is that aDNA studies constitute a particular line of research in which problems—asymmetries—of academic, political, technological, economic, and social nature converge. Accordingly, the explosion of aDNA studies has aroused a set of debates centered on these diverse locales. Such issues are contextualized in the complexities of a reengagement/reassessment of (neo)colonialism in contemporary science, specifically related to the requests for and use of biological samples by scholars from research centers and universities from Global North countries and the dissemination of analyses that emerge from those samples. All of the above are relevant, and often interrelated, facets that constitute a set of dynamics, an ecology, of global/regional geopolitical-economic relationships and interactions associated with the aDNA intellectual endeavor (and industry).

In brief, our project focuses on an analytical conceptual framework that recovers the notion of “core–periphery” as a theoretical background for studying and analyzing asymmetrical interactions in the context of contemporary techno-scientific-academic relationships. In this article, we focus on just one of the many aspects within the framework of core–periphery relationships in international scientific collaborations that can emerge:

the problem of the use and abuse of aDNA-sample requests and provisioning and the tensions that such practices can yield in the context of the asymmetry between Global South and Global North. Of course, there are many more problematic facets of these interactions, but it is not our aim to address them here. On this basis, we highlight that there are some interactions within scientific endeavors that fall within the classification of (neo)colonial relationships and also deserve a critical assessment. To do this, we offer a conceptual tool kit to be engaged, analyzed, and defined within the field of aDNA research: academic/scientific/technological (1) sovereignty and (2) sustainability, on the one hand, and the concept of (3) intermediaries, on the other.

Finally, we propose some ideas and considerations regarding both the relationship—friction (see Tsing 2005)—between the development of science and the advancement of knowledge, and the notion of “academic vulnerability” in the context of asymmetrical relationships characteristic of science, in general, and aDNA research, in particular. At first glance, one could consider that the development of any scientific endeavor is tightly intertwined with the advancement of knowledge; however, a deeper look reveals that this is not always the case, and that peripheral contexts are appropriate spaces where science and the advancement of knowledge can run in opposite directions, in contrast to what is assumed to happen in historically research core (wealthier) countries or contexts. In order to tackle these issues, we draw on work from scholars across the globe but center our critiques with experiences and contexts drawn from the Directorate of Physical Anthropology (DAF)-INAHⁱⁱ at the National Museum of Anthropology in Mexico. This means we are not just speculating about possible or probable outcomes of the ongoing dynamics on aDNA research; rather, we are pointing out issues that are in fact happening in

the academic sphere, in the particular contexts of imbalanced power, funding, and technology.

CORE–PERIPHERY RELATIONSHIPS AND HEGEMONIC PRACTICES: A CONCEPTUAL FRAMEWORK

The concepts of “symmetry” and “asymmetry” have developed in an interesting manner in the realm of science and technology studies and in the history and philosophy of science(s), and they have been part of the narrative that tries to analyze those inquiries at the intersection between science and technology. aDNA research is precisely one of these kinds of techno-scientific activities, since it is supported in a robust theoretical framework based in evolutionary, molecular, and developmental biology, but also because its effectiveness and scientific strengths are increased concomitant with technological advances associated with larger and more efficient genomic-data collection, processing, and interpretation. It would seem unnecessary to emphasize that, from this point of view, the techno-scientific asymmetries are remarkable in the global arena, and that in some cases they run through parallel lines with contemporary biocolonialism and exploitation. This is precisely why we consider the possibility of collectively building an international-regional science concerned both with the advancement of knowledge and with the local-regional development of science, which seeks to reduce asymmetries and, thus, generate a more balanced relationship between research groups from different countries and contexts.

We claim that concepts such as “core–periphery relationships” and “hegemonic practices” are suitable categories that can help unravel the kind of interactions that are taking place within certain contexts where this line of research is developed and that need to be analyzed from a bioanthropological perspective. This will allow us to build a

conceptual framework in order to support the ideas that we will set out in the final section of this article. Particularly, we keep in focus the concept of “academic vulnerability,” which can be related to cultural vulnerability and is embedded in the structural inequalities that play out in several domains, reproducing a hegemonic culture that privileges financial, economic, and/or “market” interests over those of local and noncenter/nonhegemonic participants.

Clearly, contemporary science is rooted in the articulation of a set of collective efforts, which include different countries, institutions, individuals, methodologies, funding, etc. This gives us the chance to characterize techno-scientific-academic activity as a set of transnational/transboundary collaborations. Following Hwang (2008), it can be relevant to consider the category of core–periphery for the assessment of a multilevel science that in many circumstances reproduces the process of—geo-political-economic—globalization, in which science, technology, and innovation are not outside of these existing and intervening factors (e.g., Saini 2019).

Hwang also considers that this analytical category does not faithfully represent the sort of interactions that are currently happening in academic collaborations between institutions and/or countries with different levels/contexts of infrastructure and financial support. Hwang argues that there is a “grey area” that is not the core nor the periphery and is precisely where economic, social, political, and, above all, technological inequalities are critically expressed. For this reason, Hwang (2008, 104) states, “the reenactment of *colonialist discourse* provides an understanding of the hierarchical structure of international relations in science and technology. The implication of this reenactment is that core-periphery relationships have shaped scientific practices and scientific actors’ identities; the means of reenactment have not been direct violence and political force but the interactions

between scientific actors and communities' self-referential systems, infrastructures, reputations, recognition, nationalities, political and scientific heritage, and so forth" (emphasis added). This suggests that scientists in the marginal space—the “grey zone”—of this core–periphery relationship maintain their position of disadvantage in the international context of the advancement of knowledge and the development of science, causing the core–periphery gap to widen instead of narrowing. This encourages that “only organizations with research resources and scientific competence [the core] are able to produce knowledge and distribute it efficiently. This leads to a concentration rather than an equitable distribution of scientific competence“ (Hwang 2008, 104). We argue that this analytical and conceptual framework is applicable to some recurrent practices—which can be seen as hegemonic—and that frequently take place in the scientific-technological-academic relationships that occur in the field of aDNA studies.

With regard to the issue of “hegemonic” scientific practices, Sheila Jasanoff (2004) points out that the dynamics of contemporary politics, culture, and power are intimately linked to the dynamics of science and technology (see also Saini 2019). Accordingly, it is feasible to note that the extraction/sequencing of aDNA falls into such a context of analysis, fundamentally because contemporary projects in aDNA are concentrated in the dominant spaces—laboratories, specialized research centers, and so on—where this line of research is carried out, as well as where the funding that allows it is most concentrated (e.g., the Global North). And these hegemonic centers are not often found in the peripheral locations where the source of the aDNA is often originally located; therefore, the focus often becomes the aDNA itself and not the myriad of associated and interlaced aspects of those “samples” outside of the reconstituted sequences of nucleic acids. Anthropologists and archaeologists argue that contextualizing osteological collections and bone materials,

from which molecular data are extracted/gathered/collected, is crucial for this sort of scientific inquiry (Agarwal and Glencross 2011; Armelagos 2003; Buikstra and Beck 2017; Linderholm 2018; Temple and Goodman 2014). If one does not have information regarding temporality, ethnicity, age, behavioral patterns, and so forth, what exactly does the molecular data tell you? That is, without the work done for years by archaeologists and anthropologists, many from the periphery, geneticists do not have much information in which to place the sequence variation they illuminate.

To put it another way, these criticisms and the way international scientific research is conducted “suggests that in the management knowledge industry, journal rankings are less about the quality of knowledge and more about institutions and practices that are hegemonic in nature” (Meriläinen et al. 2008, 631). For example, within aDNA research, there are many people participating in this scientific development from almost every region of the world; however, there are but a few names that appear constantly in an elevated number of scientific studies, frequently appearing as first or senior authors, and their work is published in the most prominent international scientific journals (e.g., Barquera et al. 2020; Flegontov et al. 2019; Fu et al. 2016; Krause et al. 2010; Lindo et al. 2017; Lipson et al. 2020; Llamas et al. 2016; Moreno-Mayar et al. 2018; Nakatsuka et al. 2020; Nielsen et al. 2017; Olalde et al. 2019; Posth et al. 2018; Reich et al. 2010; Reich et al. 2012; Skoglund and Reich 2016). A deeper look into the cast of researchers and scientific institutions involved in these investigations, however, gives us a better idea of what we try to point out here. Core laboratories monopolize the processes of extraction/sequencing/accumulation of (big) data. Small laboratories or institutions feature in this research, but largely as second-level participants in the whole endeavor (many times as intermediaries; see below). Museums and universities from Global South countries are

participants and protagonists of a third-level (“Third World”) science, often (only) playing the role of “sample providers.” Our concern is that the aDNA-studies ecosystem being driven by such epistemological and structural processes creates and perpetuates the inequities and (neo)colonialities we describe.ⁱⁱⁱ

This is the “ecosystem” in which scientific research activities are being developed and deployed. It is an environment that can be harmful, particularly for the development of science and the advancement of knowledge, both at the local/regional and international/global levels. For the particular case of aDNA studies, it is worth analyzing some concepts that may reflect this kind of asymmetrical relationship.

CRITICAL CONCEPTS FOR EPISTEMOLOGICAL INNOVATIONS IN THE aDNA RESEARCH ECOSYSTEM

Here, we will tackle a set of descriptions and definitions of concepts that are not commonly used in the field of aDNA studies, but we think should be. We argue that these categories and concepts are indispensable parts of a critical tool kit with which to engage aDNA research (e.g., Bardill et al. 2018; Bolnick 2016; Cortez et al. 2021; Fox and Hawks 2019; Wagner et al. 2020), and specifically the perspective we propose here.

First, we consider the concepts of *sovereignty* and *sustainability* within the framework of current techno-scientific-academic interactions, as well as the potential (neo)colonialist relationships that might be at stake in aDNA studies. We use these frames because they allow us to show the intricacies of working with human remains and the complexity of their treatment, analysis, and interpretation, not only for scientific activity but also for locals/natives, Indigenous groups, and/or other stakeholders in the core–periphery context. Second, we will define the concept of *intermediaries*, which we argue

reflects a particular manner in which Global North science has approached developing countries' heritage.

Sovereignty and Sustainability: Techno-Scientific-Academic Asymmetries

Academic/scientific/technological sustainability and sovereignty in the context of aDNA studies constitute a kind of transnational/cross-national academic activity characterized by asymmetrical relationships. One of the problematic issues linked to the concepts of academic sovereignty and sustainability in aDNA research has to do mainly with the *pace* and *speed* of anthropological science(s) versus that of genetic-genomic science(s). Fox and Hawks (2019, 582) recently stated, “investigators and commentators have begun to routinely apply the term ‘DNA-factory’ or ‘industrial-scale’ to ancient genomics (whether in publications at conferences or on social media).” This implies that some of the most prominent research centers that lead the aDNA endeavor—the “big laboratories”^{iv}—are able (and seek) to concentrate significant amounts of funding and technological and human resources to develop this activity at (industrial) scale.

An associated problematized aspect related to sovereignty and sustainability, in addition to scale, is the issue of “value.” Indeed, aDNA sequence variation analyses offer a rich additional suite of data points and corollary information to the multitude of data from a diverse array of other anthropological/archeological methodologies and areas of focus (Linderholm 2018). But the perception of many top journals and funding agencies is that the value of the data and subsequent interpretation from aDNA work is higher (more “hard science,” if you will) or more indicative of “natural” data than the various forms of other material and analyses emerging from the “softer” interpretive approaches of non-DNA-

based research. Thus, as some archaeologists and anthropologists have pointed out, aDNA studies, rather than augmenting the scope of archaeology and anthropology and the ways in which we can combine data sources to enrich the complexity of our understandings, can often end up being seen as *the* way of ratifying or rejecting older research hypotheses and/or “correcting” and refining the reality of the assertions of interpretation based on less biologically “core” materials (e.g., Linderholm 2018). This, of course, is problematic, among other things because of the reductionist perspective it can entail. Any effective understanding of genomics and human processes mandates that without a context such as that provided by bioarcheology and bioanthropology, and possibly ethnography/ethnology, molecular/genomic data has no inherent greater potential than other streams of data (Vander Linden 2018). In fact, such data can even be detrimental. As many geneticists often forget to emphasize, DNA sequences can do nothing by themselves. Thus, we argue that to make aDNA data matter, geneticists must be substantially involved with the anthropological approaches to the topics of interest and attend to the (slower) pace and speed with which anthropological studies develop—which is not necessarily the same as genetic and genomic research (Horsburgh 2018).

Vander Linden (2018, 657) argues that “obviously, aDNA research would not happen without the work of archaeologists [and biological anthropologists], and not just because we dig and provide samples but because we ask a great many questions that make aDNA research worth doing. More broadly, the occasionally strained relationship between aDNA and archaeology [and/or bioanthropology] emerges from the way each discipline tackles and explains variation in its respective data.” Thus, a more balanced strategy, in terms of pace and speed, is needed between bioanthropological/bioarchaeological and

genomic interests. Anthropological research cannot occur at industrial scale, as it is not only (or usually) about the processing of genomic samples. Whether it involves fieldwork, osteological analyses, ethnographic or ethnohistorical investigations, etc., it is ultimately the link with the people and cultures, histories and presents, that constitutes the production of relevant aspects of this line of inquiry. The contextualization of the gathered material during fieldwork, and its interpretation, and, thus, data collecting and the corresponding analysis is often a much more complex and much slower process than aDNA-sample collection, extraction, sequencing, and analysis.

It is not only the pace of the science that is an issue, but also the interface with the very materials that constitute the data with which we work. As David Reich (2018, xvi) points out, “We are now producing data so fast that the time lag between [aDNA] data production and publication is longer than the time it takes to double the data in the field.” This is relevant, as it poses a dilemma: aDNA extraction, amplification, and sequencing techniques (required for an aDNA researcher) use bone samples that must be destroyed, at least partially or completely (Fox and Hawks 2019; Sirak and Sedig 2019), in order to answer particular research questions. This issue of material destruction is directly related to our key term of academic sustainability and the need to establish more-informed research questions. “It is therefore urgent that, rather than sequencing an ancient genome in the hope that something interesting will emerge, researchers state up front what questions they are seeking to answer” (Fox and Hawks 2019, 582). Anthropologically focused, and situated, questions can be slow in their development and implementation.

We consider that one operational definition of academic sustainability in this context is the “adequate and efficient management of bone evidence and its potential use

for anthropological research purposes; both for present and for future generations of researchers and also for the development of more efficient techniques of data collecting” (e.g., Fox and Hawks 2019). While there is no standard definition of academic sustainability in the literature related to this topic, Fox and Hawks’s (2019) essay points in this direction.^v The methodology of extraction used should privilege more than simply the cost–benefit relationship—or the optimization—of the “information” that can be obtained from an invasive procedure, which frequently cancels the future research with more efficient and less destructive techniques. According to Fox and Hawks (2019, 581–82), “Extracting the best-quality DNA from ancient remains requires the partial destruction of those specimens. And once bones, teeth, hair and so on are ground into dust, future opportunities for using them to understand our past are lost.” Unfortunately, this is in many cases what is happening because of the possible pace of obtaining and analyzing genomic-molecular data. For instance, “Last year, a team looking at the morphology of the inner ear noted that researchers were breaking open bony labyrinths and drilling into hundreds of petrous bones for DNA without first taking photographs, or using scanning techniques . . . to make morphological records” (Fox and Hawks 2019, 582). Knowledge, heritage, and possibilities for academic engagement were lost; sustainability of a broader, and possibly more ethically informed, mode of research engagement takes a back seat to the scale, pace, and value of aDNA research.

The other relevant concept that is important to address here is *academic sovereignty*. We consider academic sovereignty to consist of the full agreement and some form of equitable engagement between the different *stakeholders* who make up an investigation on what rights and obligations each of them must fulfill. Again, it is difficult

to find in the specialized literature a straightforward definition of academic sovereignty, or even a recognition that it is a critical aspect of aDNA projects (but see Bardill et al. 2018; Cortez et al. 2021; Wagner et al. 2020). However, some attempts have been made in the context of broader genomic studies (Benjamin 2009; Claw et al. 2018; De Vries and Pepper 2012; Wagner et al. 2020); nevertheless, these are more properly oriented toward the category of “genomic sovereignty.” A similar concept derived from political discussions in the Mexican senate within the framework of biomedical studies also focused on genomics, where the interests at stake were of foreign countries and companies seeking to collect molecular data obtained specifically from different individuals of Mexican populations, without any restriction or protection. Drawing on all these sources, we suggest that the concept of academic sovereignty “rests on the fundamental premise that unique patterns of genomic variation are sovereign resources and should be protected from foreign prospectors” (Séguin et al. 2008b). Moreover, we emphasize that these sorts of relationships must be part of a new era of international scientific collaborations, conflicts, and tensions—negotiations—in the current context of aDNA research and international scientific collaborations. But the challenge remains in that the contemporary landscape of core–periphery relations in the realm of aDNA research necessarily poses (and maintains) asymmetrical interactions and potential (neo)colonial/biocolonial relationships that reproduce world/regional geopolitical differences. Recognition of, and engagement with, sovereignty of the sources, contents, and contexts of the entire range of subjects, samples, and processes related to aDNA analyses must be a central feature of the structure of such projects.

The set of mutual understandings we propose here is a central component in the claim that aDNA studies can best develop in an environment of academic, scientific, and technological sovereignty and sustainability. Such concepts and assertions do not seek to close borders and prevent collaboration between countries, with private companies or with other agents, nor is this a nationalist stance. On the contrary, this approach seeks to defend the importance of shared and sustainable, and just and equitable, control over the materials, evidence, funding, and human resources that collaborating parties contribute to the research and, thus, give concomitant and equitable value to each participant. Following Séguin et al. (2008a, 490), the analytical category of genomic sovereignty allows different countries to get access to the human genomic variation in their population(s) in order to “encourage local innovation and participate as equal partners in the global knowledge-based economy.” Slabbert and Pepper (2010, 436) support this way of considering this concept and define it as “the capacity of a people, a country or a nation to own, to control both access to and use of, samples, data and knowledge concerning or emanating from genomic material.” However, there are also justifiable warnings about misuse and criticisms of this category. Ruha Benjamin (2019) argues that genomic sovereignty can convert into “a project designed to benefit those already in power, and could perhaps lead to further exploitation of Indigenous peoples living within the confines of particular nation states” (see also Claw et al. 2018). De Vries and Pepper (2012) point out that the concept of genomic sovereignty is limited because it does not contemplate genomic data in its analytic form but focuses only on the material evidence (the sample) from which genomic information is extracted.

In any case, we argue that it is relevant to discuss and include these concepts in the generative stages of aDNA research because it is important to keep a *sustainable* pace and

speed in this line of study. Otherwise, we risk moving outside the capacity of preparing or training scientists in each country and losing the possibility of processing biological (genomic) samples and engaging in analyses in a *sovereign* fashion. This focus on sustainability and sovereignty also brings to the fore another issue in the actual processes and unfortunate contemporary realities of the aDNA research landscape: the intermediary phenomenon.

Intermediaries

This is another major aspect that must be included in the ecology of aDNA studies we describe: the potentially liminal, problematic, and unethical role that some individuals and institutions can play in obtaining samples for the extraction, amplification, and sequencing of aDNA. Our contention is that an intermediary can be characterized as follows: a person who obtains one or more samples from an institution, museum, or research center to which they do not belong, in order to be processed in a laboratory or scientific institution to which they do not belong, with the main aim of taking part of a publication or authorship. This is not meant to refer to the work of students who are part of true collaborations or of individual researchers who play small parts in a large team project. Rather, we identify this as a phenomenon in those scientific projects in which the participation of the intermediary consists mainly (or maybe only) of the sample management/access/delivery.

Now, imagine the following situation in the asymmetric relationships we have already described above. Let us say that a research group from a specialized laboratory in evolutionary studies with aDNA has previously published relevant data on migration history and the first peopling of Europe and Asia. To do this, they had managed to obtain significant and coveted samples from several different regions of the world, and they aim to

move forward to expand these analyses by obtaining aDNA from Mexico, for instance. It is clear that the objective is to understand how the peopling of the Americas occurred and the details about the mobility and settlement of populations in that critical geographical area lining north and south continents; we assume that the goal will be to contrast the new genomes obtained from ancient individuals previously dated with already published data. Following this scenario, if there develops a relationship between a research group in a developing country and one of the “cores” of aDNA work, it must involve mutual interdependence.

But there are complexities in such relationships. On the one hand, researchers in the source locale, who are responsible for the custody and management of the human remains being sought, will tend to establish a slower pace to work with these materials because they know the great potential bioanthropological/bioarchaeological/social/patrimonial value of their samples; they are not in a hurry to publish data and analyses, but rather are thinking about what may be the best ways to continue with the production of situated knowledge based on a project that has multiple frames of value and meaning, beyond the industrial scale/pace of analyses and publication. Furthermore, they may prefer to disseminate results in a slow(er) fashion in order to optimize the gradual delivery of their publications, consultation with key stakeholders, and appropriate opportunities for engagement by the various communities of scholars involved in larger related projects (if such projects exist). On the other hand, the “core” laboratory that is focused on the possibility of further unraveling the peopling of an entire continent will tend to ask for various samples, with the goal to work at full capacity and industrial scale. This results in a very evident asymmetry in the pace and speed of the research. We assert that the “core” laboratory’s goals have

often been reached despite the objectives of the “periphery” collaborators’ pace and (infra)structures, via the insertion of intermediaries into the equation. The intermediary is an actant who circumvents the multifarious processes of many “source” researchers’ modes of engagement and delivers samples directly to the “core” teams for industrial-grade academic science.

The typical intermediary usually has some support from an institution or university, related to the possibility of obtaining samples. The process (negotiation) begins when the intermediary communicates to the aDNA laboratory that they have access to samples, as long as funding for the necessary research and coauthorships are guaranteed from the aDNA laboratory. As a consequence of this negotiation, there exists the possibility of offering a very attractive publication to each person who contributes with samples from the collection that they have access to. This is the way that aDNA laboratories should not work, and of course, it is not the rule, but it is a common practice in core research centers. Such practice ignores the needs and objectives of colleagues and has the potential to produce great collateral damage. For example, if the researcher who provides samples barely participates in the research project, in the establishment of the research question(s), in the configuration of the project, in the discussion of the results, in the language and journal they want to publish their work, and so on, their role becomes passive and unscientific, and there is no real partnership with the laboratory members. In other words, an original contribution from a local researcher is left aside and their participation is replaced by the role of a sample provider.

Personal relationships, scientific dialogue, student mobility, and other emerging inputs resulting from transdisciplinary and internationally guided projects will not happen

as long as the intermediary scheme is maintained. What does this tell us about the way these scientific inquiries are being shaped? What is the role that the asymmetric context described before plays in perpetuating these unequal relationships? We are in the position to affirm that the “trade” of osteological materials for scientific research is grounded currently in the way that intermediaries are working to manage the samples they get. Furthermore, such actors are largely free from legal and ethical responsibility and ultimately may not have the slightest awareness of the importance of heritage conservation. An intermediary often does not know the collections nor processes to interpret data derived from it and did not take part of the excavation, retrieval, or inventory of the material. In other words, what this figure offers is something they do not own and do not know at all, but they manage to act as if they did.

As we have said, the intermediary phenomenon is not something fully new but is part of the reshaping by which scientific colonialism is creating sophisticated ways to reproduce itself. We are against the proliferation of this praxis. In addition, we state that this is the consequence of the unwillingness to follow balanced, organized, and systematized guidelines to engage in a healthy scientific endeavor. It is an example of how the constraints of the institutional frameworks can affect the scientific results due to the bureaucracy that limits the establishment of more equitable and symmetrical relationships, as in the Mexican case. This last assertion is important because we had focused our critique on the internationally guided scientific collaborations; however, there are important issues to raise in the domestic context, also related to asymmetrical relationships and unethical and hegemonic practices, among others. Rather than being interested in an anthropologically contextualized, academically sustainable, and sovereign advancement of

knowledge, such processes seem more focused on appearances in high-impact publications. Intermediaries are, we insist, a detrimental agent to scientific praxis.

A VIEW FROM A ZONE OF VULNERABILITY

Our goal in this article was to add to the frame and context of the emerging project of enhancing epistemological and ethical engagement in aDNA research. We sought to offer a structure, via a set of concepts, to interrogate the dynamics of vulnerabilities of scientific praxis in aDNA research and to illustrate the interplay between hegemonic science and the heritage of developing countries. In that vein, it is worth asking where we are when a (or the) leading scholar in these aDNA technologies states, “Today, however, things are very different. We have several hundred thousand times more data, and in addition we have access to the rich lode of information contained in DNA, which has become a more definitive source of information about the past population movements than the traditional tools of archaeology and linguistics” (Reich 2018, xv–xvi). Such a perspective is powerful, as it emphasizes the substantial gap between big laboratories and smaller research institutes, between the main research centers in the Global North and those dispersed around the world. These are not just economic and technological asymmetries, but also epistemological ones, which reproduce unequal interactions and a (neo)colonial attitude expressed both in terms of the directionality in which funding for aDNA scientific research flows and in the bolstering of the scientific (epistemic) position of molecular biologists and/or paleogenomicists. It is not that the majority of researchers specialized in aDNA research actively or consciously promote such epistemologies, but that over the past few decades, the structure, location, and funding of aDNA research laboratories/activities has

proceeded largely in a manner creating practices that are hegemonic and harmful for a relevant number of scholars and researchers, particularly in the peripheral context.

We want to highlight that the research supported to possibly recover aDNA from osteological remains impacts a wide array of academic fields, but also, more broadly, the conceptualization and structuring of research endeavors and landscapes. On the one hand, we acknowledge the need to advance global scientific knowledge, but on the other hand, we assert that the local development of researchers and the research landscape is equally necessary. It might seem that these are two sides of the same coin, and that if knowledge progresses, then the logical consequence will be the local development of science.

However, this is not a necessary outcome of the geo-political-economic biases (the *ecology* we have described) that exist when research is conducted bilaterally or even multilaterally. The technological potential of developed countries (the core) significantly outweighs that of developing countries (the periphery). In contrast, in some cases, patrimony, in terms of biodiversity and cultural heritage, is a feature that distinguishes much in the periphery. This creates interest from those who own and can deploy highly sophisticated technology and scientific development to gain valuable information. In other words, economic, social, and technological asymmetries are reproduced in the scientific-academic domain: countries with a wealth of heritage are potential territories for the extraction or exploitation of evidence and biological samples. That is, the advancement of knowledge, in a global sense, differs from the interests and needs of local development of science; each country/region has its own problems and virtues.

In these asymmetrical relationships, it is feasible to account for the possibility of generating a double objective (double agenda) of scientific research interests, which is not

always conspicuous. It is not only a matter of knowing where our ancestors walked but also of accumulating a significant amount of information with potential usefulness in different areas for the future—for instance, biomedical, pharmaceutical, and even legal or commercial. This implies that in the most developed countries, the advancement of knowledge and the local development of science usually run at a faster pace and speed than in developing countries because techno-scientific activity is based on economic and technological capabilities. What would have to happen is that the countries with the greatest resources should try to reduce the gaps in that pace and speed by pushing the *decolonizing* of scientific praxis. However, what often happens is the opposite: the most powerful countries exploit the underprivileged ones and widen the gap in the local development of science, perpetuating the tradition of scientific colonialism, but in a novel fashion. For example, the Dirección de Antropología Física-Instituto Nacional de Antropología e Historia (DAF-INAH) receives research projects that request the provision of dozens of samples to extract aDNA. The vast majority of these requests are made by intermediaries, who do not even know the osteological collections they are interested in sampling and have not had any contact with the principal investigator in charge of the collection. Of course, we are against these sorts of scientific “hegemonic” practices. What intermediaries are really looking for is to obtain samples to be able to negotiate publications, authorships, and so on, which are highly coveted scientific products for their curriculum vitae and professional value. Indeed, the advancement of knowledge occurs, but at the expense of generating greater inequalities between the groups that carry out the collaboration.

The latter leads us to the possibility or need to reflect on a final concept, *academic vulnerability*, in terms of potential geo-political-economic tensions and asymmetries, which are of course another way in which cultural vulnerability is reproduced. Controversial

opinions have recently been published on how big laboratories conducting studies with aDNA get samples and develop these huge research projects (Lewis-Kraus, 2019) through intermediaries and students who are used for these purposes. In addition to the theoretical-methodological issues, opinions on the ethical aspects underlying this type of research and scientific practice stand out. In this context, the core laboratories with powerful human, financial, and technological resources are in a kind of “genomic race” to develop a “global genomic atlas” with the greatest amount of information of this sort. In that race, only the world powers play: Global North countries. From our perspective, it is necessary to speak out about these issues and analyze the problems arising from political, social, economic, technological, and academic asymmetries and hegemonic practices, which are embedded in the structural imbalances and inequalities that give place to the cultural vulnerability in which developing countries are usually the most affected. This is especially critical in the role played by smaller laboratories, institutes, research centers, and/or museums of the periphery that do not have the power to develop and fund industrial-scale (and pace) projects, and that in some circumstances are forced to play the role of intermediary themselves in order to continue in the scientific circuit.

With this in mind, it is possible to conclude with a mental experiment or an interrogation, resuming the notion of “vulnerability”: What would happen to the “nascent” discipline of aDNA if a significant number of countries refuse to continue contributing biological samples and/or bioanthropological materials, tissues, etc., and particularly without their contextualization? In doing so, these countries would seek to defend, by this intransigent (but maybe inevitable) means, the sovereignty and sustainability of their own heritage and the local development of science. In that case, who would be more *vulnerable*:

the core, with its hegemonic science and its industrial-scale praxis, or the periphery, with the heritage and the data everyone seeks to obtain?

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NOTES

ⁱ See also Summer Internship for Indigenous People in Genomics (SING) Consortium (<https://www.singconsortium.org/>) as a recent and relevant project that seeks to critically examine these ethical, epistemological, and/or geopolitical consequences and also to create and situate aDNA research from/in the perspective of Indigenous cultures.

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ⁱⁱⁱ We do not ignore there are many more issues to tackle in this context, but it is not in the scope of this essay to highlight and elaborate on them. See, for example, Cortez et al. (2021), Fox and Hawks (2019), and Wagner et al. (2020).

^{iv} These institutions consider as a primary objective of their research to reconstruct the different routes through which our ancestors roamed and thus “peopled” the world (e.g., Reich 2018); in other words, they support the idea that it is necessary to generate a map of global human migrations across “prehistory” and “history.”

^v See also Keolu Fox’s “Decolonizing Genetics” Twitter conference presentation, 2019.