Paleoenvironmental humanities: Challenges and prospects of writing deep environmental histories

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Abstract

Environmental uncertainty, climate change, and ecological crisis loom large in the present and permeate scenarios of potential futures. To understand these predicaments and prepare for potentially catastrophic scenarios, there have been repeated calls to explore the diverse human–climate relations of human societies in the past. The archeological record offers rich datasets on human–environment articulations reflected in artifacts, ecofacts, and their relational entanglements. Much of these human–environment conjugations are, in the absence of written records, only accessible archeologically, yet that discipline has played little role in the “environmental turn” of the humanities or the climate change debate. In an effort to articulate archeological research traditions with these concerns, we frame the notion of the paleoenvironmental humanities (pEH): a deep-time training ground for current ideas and theories on the interrelationship of human behavior, climate, and environmental change. The key objective of the pEH is to offer a rejoinder between ecological reductionism and the adoption of full-scale environmental relativism, opening up new interpretive and comparative terrain for the examination of human–climate relations. We probe the potential of this perspective by drawing on insights from Pleistocene archeology. The long-term temporalities of the Pleistocene, we argue, promote alternative imaginaries of the human–climate nexus and draw attention to similarly long-term futures. We end our proposal with a reflection on the responsibility of archeological practitioners to balance hopeful narratives of human adaptability with those of societal collapse, countering the emergent linkage between climate skepticism and right-wing nationalism, and to bring such issues to public attention.

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KEYWORDS
climate change, deep history, eco-criticism, environmental archeology, environmental humanities
1 | INTRODUCTION

Increasing environmental uncertainty, rapid climate change, and widening ecological crisis loom large in the present, and they permeate scenarios of potential futures (Field et al., 2012). In order to understand these predicaments, and to premeditate on such potentially catastrophic futures, there have been repeated calls to explore the diverse human–climate perceptions and relations that characterize human societies of the past (Hulme, 2008). The archeological record offers rich and unique datasets on human–environment intersections reflected in material culture—artifacts and ecofacts—and its relational entanglements with the temporality of the long-term. Furthermore, the introduction of the hotly contested notion of the Anthropocene as a new geological epoch characterized by human-dominated climates (Crutzen & Stoermer, 2000) collapses the sharp distinction between earth history and human history (cf. Edgeworth, 2014). It shifts our attention to how this “conjoined history” (Chakrabarty, 2014) is preserved stratigraphically and in artifact proxies that, in the neologisms of our age, are referred to as “technofossils” (Zalasiewicz, Williams, Waters, Barnosky, & Haff, 2014). Indeed, much of these past human–climate–environment relations are, in the absence of written records, only accessible archeologically. Yet, paradoxically, archeology has played little role in the “environmental turn” of the humanities, which has touched such diverse subjects as literature studies, history, and anthropology (Berghthaller et al., 2014; Hulme, 2011).

Major textbooks, edited volumes, and reviews in environmental history (e.g., Hughes, 2001), the environmental humanities more broadly (Berghthaller & Mortensen, 2018; Heise, Christensen, & Niemann, 2017; Robin, 2018) or even environmental studies writ large (Castree, Hulme, & Proctor, 2018) contain very little in the way of archeological cases or references. In part, this can surely be explained by the historical contingencies of institutional placements and intellectual alignments. In North America, where the environmental humanities have emerged most forcefully (see Emmett & Nye, 2017), archeology is a subfield of anthropology and normally not placed in humanities faculties (Balée, 2009). In Australia, the environmental humanities are dominated by critical literature studies and often adopt postmodern and sometimes even anti-scientific stances (e.g., Cianchi, 2015) that do not sit comfortably with most ecologically minded archeologists. In Europe, the environmental humanities seem to be directed by environmental history and draw heavily on written sources with a strong focus on the last 1,000 years (e.g., Mauch & Pfister, 2009). Such intellectual placements go hand in hand with discipline-specific vocabularies, conferences, educational paradigms, and publication trajectories. Meant neither as a critique of this development nor of the current situation, we merely note that archeology, despite its rich tradition of investigating the role of climate and environmental change in past societal developments, remains peripheral to the environmental humanities discourse as well as the debate on climate change at large.

While archeology may be late in joining the environmental humanities, we here offer an opinionated overview of what the discipline can contribute to interrogations of climate change, and also what archeology can do to promote climate action. In relabeling a politically and narratively conscious environmental archeology as “paleoenvironmental humanities” (pEH), we seek to reach out to our colleagues in archeology, but also to those in the environmental humanities and the sciences. We offer this perspective in the hope of stimulating head-on engagement of archeologists with contemporary—and hence both scientific as well as inevitably ethical and political—issues of climate change. The current climate crisis and our imaginations of potential climatic and societal futures are foundational to the environmental humanities. We posit that archeology provides a mirror, albeit darkly, reflecting long-term societal futures in similarly long-term pasts. Given the importance of temporality in such prognoses and prognostications—be their horizons immediate, electoral, or intergenerational—bringing in conceptual tools and evidence that can be used to construct and constrain such long-term futures is, we argue, now timelier than ever.

2 | ENVIRONMENTAL ARCHEOLOGY: CLIMATE, ENVIRONMENT AND HUMANS IN THE LONG TERM

Archeology occupies an arguably unique position among the human, natural, and life sciences. Archeologists have long been occupied with ecological questions and the explanatory challenge of climate change. The discipline has even developed a plethora of specialisms—environmental archeology, bioarcheology, and geoarcheology—to deal with past human–environment relationships (O’Connor & Evans, 2005; Reitz & Shackley, 2012). This disciplinary matrix has also created a paradox, however. While there is much thematic and topical overlap between the environmental humanities and environmental archeology, the latter represents research traditions with a strong natural scientific—as opposed to humanistic—orientation, rooted in a methodological fellowship with geography and the earth sciences, paleoecology,
botany, and zoology (O’Connor, 2004; e.g., Pollard, 1999), now digitally enabled (Siart, Forbriger, & Bubenzer, 2018) and increasingly complemented by a range of biomolecular approaches (Brown & Brown, 2011). By and large, environmental archeology perpetuates the natural, soil, and life scientific legacy of interrogating the human–environment nexus (but see Richer & Gearey, 2017), often lacking the critical sociocultural perspective so strongly foregrounded by the environmental humanities.

In addition to the fragmentation afforded by these specialisms, there is a deep-seated controversy about the status of the natural environment in archeological knowledge production (Arponen et al., 2019)—a discipline-internal quarrel fuelled by opposing preconceptions of human biocultural evolution and underpinned by period-specific preoccupations and prejudices. For example, in later prehistory, historical archeology, and archeologies of the so-called “early civilisations,” the guiding assumption is often that the natural environment acts as some kind of inert backdrop of cultural history (e.g., Thomas, 1998; Trigger, 2003). As Hudson et al. (2012, p. 314) perceptively note, a strong focus on the environment has traditionally been regarded as “depriving preliterate societies of history and thus supporting colonialism.” In earlier prehistory and especially in Pleistocene archeology, by contrast, the role of the natural environment is commonly foregrounded (Livingstone, 2012) and ecological factors are much more routinely invoked as structuring elements of human action, cognition, and adaptation. Doubtlessly, the disciplinary politics of archeology are intimately bound up with these foundational nature-culture binaries. While rarely made explicit, the debate among environmental determinists, possibilists, and eliminists (Stanton, 2004) continues to structure archeological institutions, discourses, and master narratives.

For archeology, therefore, the “environmental turn” offers the opportunity to rearticulate intra-, inter-, and transdisciplinary engagements with the environment and issues of past climate change (Jackson, Dugmore, & Riede, 2018). The key challenge, especially pertinent for archeologies of the deep past and human origins, is to acknowledge that the humanities have much to offer in framing and resolving long-standing ecological questions, and that these questions cannot be adequately addressed simply by rectifying chronologies, seeking correlative patterns, and interrogating the environmental phenomena themselves. While these latter aspects necessarily remain an important prerequisite of studying human–environment relations in the past, coming to grips with the diverse yet fundamental human, more-than-human and socio-technological dimensions of the problem has never been more important than now (Kost & Hussain, 2019). The prism of the environmental humanities promises to decentralize the discourse on the deep past from humans themselves and to give proper credit to the undeniable influence of climatic and ecological actions and actors in early human history. In other words, the “environmental turn” promises to balance an unnecessarily polarized debate, to render the status of climates and environments an empirical yet multifaceted question again, and to amend flawed narratives of historical progress, environmental determinism, or climate change denial.

Archeologists, in our view, have a pressing responsibility to deflect ideological instrumentalizations of the past. This comes to the fore when, for instance, alleged patterns of material culture or aDNA are co-opted to serve nationalist, capitalist, and colonialist agendas (Friedman & Hofmann, 2019; Mrozowski, 2010) but it is now also acute in relation to the environment (Riede, Andersen, & Price, 2016). Here, archeologists can make a real difference in how the past is appropriated and its human–environment dynamics are conveyed and communicated (Kauffman, Kelly, & Vachula, 2018; Rockman, 2012). In the Anthropocene, all environmental archeology is political (cf. Swanson, 2016) and it is therefore vital that archeology learns to avert the epistemological extremes of its own disciplinary history (cf. Arponen et al., 2019; Livingstone, 2012) and to navigate both climate determinism and marginalization more effectively. The objective must be to embrace past humans as earth-bound creatures and to make space for a less-anthropocentric perspective on the early evolution of our species and the planet, so that the deep history of the hominin lineage can come into view as a genuine co-production of humans and nonhumans encompassing techno-artifacts, environments, animals and climates (Box 1).

The pEH approach also promotes a critical re-consideration of the possible contribution and role of archeology in the symphony of academic disciplines now concerned with human–climate relationships and the future of humanity. In our view, the key recognition is that archeology can operate on a range of observational scales from tiny to towering, some of which are not readily or not at all available to other disciplines tackling the human–environment nexus. Archeological research facilitates global comparative frameworks (d’Alpoim Guedes, Crabtree, Bocinsky, & Kohler, 2016), the investigation of past earth-system dynamics that include human agency (Stephens et al., 2019) and the careful scrutinization of human–climate interactions across many thousands and sometimes millions of years (Bräke, 2015; Figure 1). This unique perspective enables the study of long-term correlative and causal dynamics in both the human and climate realms, and to examine such aspects as shifting power-relations, trade-offs, constraints and interdependencies between the two, as well as between mediating domains such as biodiversity. The pledge, however, is not merely to
document the necessary synchronies and correlations at the human–climate interface, but also to expose time lags, thresholds, and feedback effects showcasing the complexities of how climates have always framed but also underdetermined human biocultural evolution and how past humans, in turn, have variously engaged with and manipulated their climatic and physical environments.

The umbrella of the pEH aims to align the sensibilities of environmental history, deep history, and big history in relation to contemporary understandings of climate change and its societal role (cf. Dukes, 2013). The hope here is also to decolonize our intuitive and ready-made assumptions about time, climate, and history rooted in Western modernity (Porr, 2019), and to create more space for dynamic, discordant, nonlinear, and multimodal apprehensions of temporality and eco-cultural processes (Bailey, 2007). This critique must be completed by serious reappraisals of culturally, technologically, cognitively, and physiologically mediated perceptions and understandings of climate change so that archeologists can begin to distil and compare deep-time "cultures of climate" (sensu Hulme, 2016), and to carefully investigate their linkages with archeological patterns of human response, coping, and decision-making across different spatiotemporal scales. Such analyses may expose what is otherwise easily overlooked—relationships and articulations of environmental processes and material culture developments operating beyond the "micro" and "macro" scales of traditional historical and ethnological analysis (cf. Audouze & Valentin, 2010). We would argue that these nodal human–climate articulations, formed in the coppice of “thick time” (Shryock, Smail, & Earle, 2011), have become an inescapable part of what it means to be human. Archeology provides the disciplinary anchor point to identify, explore, and clarify them.

A key capacity of the pEH rests in backward diagnosis—the careful and detailed disassembly of temporally extended chains and internally structured assemblages of causality, co-dependence and contingency and to reverse-engineer their documented consequences (cf. Moshenska, 2016)—which, in contrast to prediction, allows scholars to investigate the unplanned, unanticipated, and uncontrollable in human history as the result of our very own niche-constructing agency (Boggs, 2016; Ellis, 2015; Riede, 2019b). Such “backward problem-solving” (Messler, 2014, p. 17) can capture and interrogate both the preconditions and repercussions of specific choices, processes, and interferences within and across different cultural trajectories. The ensuing perspective recasts the archeological record as a space of grounded quasi-simulation and counterfactual experimentation in which archeologists can assess the differential impact of various input parameters under shifting human–climate situations on accruing long-term trajectories of coping. Such quasi-experiments with different constellations, possibilities, and ramifications of action bring both resilience and success as well as their opposite—vulnerability and failure—to attention, and can be made to work in risk management and planning (Riede, 2017a).
The archeological record is the only tangible product of millennial-scale experimentation in human ecodynamics, the lessons of which are most effectively uncovered in a joint effort (Rick & Sandweiss, 2020) and may be curated for the future (Barthel, Crumley, & Svedin, 2013). The examination of the archeological record contextualizes current future-making scenarios, flags up alternative developmental potentials, and allows calibration of pertinent decisions against deep-time experience; our notions of possible futures strongly depend on our understanding of realized pasts.

In the face of a dawning Anthropocene defined by the emergence of novel—or more precisely, historically unprecedented—environments and climates (Morse et al., 2014), the expertise to map, compare, and assess a fuller range of human–climate possibilities and nonanalogue ecological settings becomes imperative. The deep-time records furnished by archeological investigations offer the opportunity to retrieve, at least indirectly, long-forgotten or neglected collective-historical lessons and to stipulate climate change readings outside of the categorical grid of the “Axial Age” (sensu Assmann, 2018) of the so-called “great civilisations.”
Archeology’s access to the sweep of the human experience beyond the cultural filters of worldviews of relatively recent origin, coupled with the potential to retrieve past collective memory cross-culturally and trans-temporally, promises to issue fragments of deep-historical knowledge and possibly subaltern modes of understanding which may—for instance, under the rubric of Paleoknowledge Systems—be mobilized in a similar way as Indigenous and Traditional Ecological Knowledge to inform present-day ecological and climate change challenges (Gómez-Baggethun, Corbera, & Reyes-García, 2013).

Considerations of the climate-mediated lifeways of non-Western societies can be seen as an antidote to claims of inherent supremacy of modern, capitalist ideologies (cf. Wolf, 1990) and as providing hints of different ways of relating to climate and the environment (Hastrup, 2013). They help pluralizing and deliberately complicating our knowledge on human–climate interconnections (Hulme, 2018). Archeological deep-time explorations of past lifeways under the umbrella of the pEH provide similar antidotes and narratives in a diachronic, literally stratified and parable-like fashion (Gauvreau & McLaren, 2016); they oppose the apparent obsession of Western modernity to define itself in sharp opposition to a supposedly outmoded, “traditional” past. While archeology can at times lay claim to specific sustainability solutions (Guttmann-Bond, 2019; but see also Lane, 2015), the objective of the pEH is not so much to find a single answer to any given contemporary climate problem or to promote a unified pool of knowledge but rather to profit from the naturally heterogeneous and diverse set of ecological experiences associated with the human deep past, and to raise awareness of the power of archeological narratives in forming intergenerational futures.

While the notion of resilience plays a vital role in archeological human–climate investigations (Redman, 2005), at least equally important is the archeological evidence for vulnerability and failure. Although the precise nature and extent of past societal collapses remain controversial (McAnany & Yoffee, 2010), the archeological record proffers countless examples of how human societies have failed in the sense of collapsed elite superstructures, demographic decline (Cumming & Peterson, 2017), and societal transformation at human costs that would not be acceptable by any ethical standard today (cf. Reuveny, 2012). Before anything else, however, archeology articulates geological or paleoecological views of deep time with anthropocentric, modernist perspectives that forefront the more recent past as exclusively generative of contemporary and future conditions. This accruing perspective has the capacity to throw new light on the long-term consequences of various ways of human involvement with local-to-global climates and ecosystems beyond the grasp of “shallow time” approaches (Briggs et al., 2006; Crumley, Laparidou, Ramsey, & Rosen, 2015; Rull, 2014).

3 | PALEOENVIRONMENTAL HUMANITIES: CONTRIBUTIONS AND CONSEQUENCES FOR UNDERSTANDING CONTEMPORARY CLIMATE CHANGE

We propose the pEH to align the rich, long-term archeological datasets on human–environment interactions with issues, concepts, and concerns of the emerging environmental humanities and the climate change debate at large. The core objective of this endeavor is not only to offer a rejoinder of ecological reductionism and environmental relativism, but also to bring long-overlooked deep-time knowledge on human–climate relations to bear on contemporary quandaries. Due to its inherently hybrid disciplinary make-up, archeology provides the opportunity not only to extend the discourse on human–nature dynamics far beyond the limits of historical records, it may also serve as a paragon case of synthesizing conceptual and interpretive innovation in the environmental humanities with rapidly developing, robust analytical toolkits and methods in environmental archeology and paleoclimatology. The promise is an inclusive and analytically powerful yet conceptually sensitive approach to human–climate intersections based on diverse deep-time records.

A central mission of the pEH would be to systematically map the many path-dependencies and similarities in human–climate interactions as well as the differential susceptibility of varying modes of human life to climate change. Another prospective angle of analysis, hitherto underdeveloped and rarely pursued in archeology or the paleosciences, targets the important role of autocatalytic trajectories of technology and material culture, restructuring the available options and developmental state spaces of past human–environment nexuses and the evolving exposure and vulnerability of humans to climate change. Archeology, we posit, holds the key here to unravel the ramifications of material culture, technical and ecological knowledge, know-how and materially mediated social relations for human adaptability, developmental plasticity, and future-making (Fox, Pope, & Ellis, 2017).
The contribution of the pEH, we posit, is to reframe the wider discourse on climate change in terms of our quickly expanding deep-time knowledge and to demonstrate that humans can neither be characterized as beings fundamentally divorced from nature (cf. Anderson & Perrin, 2018), nor can their cultural existences and potential futures be sufficiently understood by unidimensional climate-driven stimulus–response models. The archeological evidence of the human deep past on the whole does simply not conform to very strong notions of environmental determinism nor does it conform to the notion popularized, for instance, by the “eco-critical manifesto” (www.ecomodernism.org), that humans were always flexible enough to cope with all kinds of adverse climate situations and that there is thus little reason to suspect that humanity will be unable to continue doing the same in the near and far future—an assumption that is empirically unfounded, naïve, and dangerous. Likewise, the interdisciplinary evidence mustered by the pEH does not support the conclusion that simply because some animals and plants have benefited from their prospering human neighborhoods from early human history onwards, should we expect that these organisms will find ways to also cope with the coming environmental transformations. What the pEH are able to demonstrate, instead, is that ecological success and failure are two sides of the same coin, not to be separated either analytically or ethically. While the remote human past teaches us that there is much hope and possibility with regard to our shared planetary futures, it also makes clear that we need to be extremely wary about our environment and the way we treat, curate and manipulate it. Effective and sustainable future-oriented ecological stewardship, therefore, references our knowledge and understanding of the human and nonhuman past, and climate action in the present can only benefit from the complex, multilayered horizon of deep-time human–environment–climate relations as furnished by the combined effort of data-driven paleosciences and theoretically versatile and conceptually sensitive humanities perspectives.

4 | PLEISTOCENE ARCHEOLOGY, CATALYTIC CLIMATES AND THE DARK MIRROR OF HUMAN DEEP HISTORY

While climate scientists use instrumental and, to a lesser extent, proxy data to make prognoses of future climates, one important perspective of the Anthropocene debate is that these future climates and their ecological correlates will likely have no analogue in the recent past. Although the societal conditions of today differ radically from those of the past, the last time humans had to contend with nonanalogue and hard-to-predict environments was the Pleistocene and its early Holocene aftermath (Burroughs, 2005). The pEH pry open a window into the otherwise inaccessible yet pervasive deep history of human societies—covering, after all, over 96% of all human history—before the advent of the climatically stable and from an evolutionary perspective rather atypical Holocene linked to the emergence of increasingly hierarchical and agricultural societies (Mattison, Smith, Shenk, & Cochrane, 2016). Indeed, paleoecological data, together with proxies of human impact, now indicate that human action has been integral to the Holocene’s climatic and ecological trajectory for >10,000 years (Lyons et al., 2016; Ruddiman et al., 2016). Consequently, Pleistocene archeology—the discipline concerned with this earliest period of human history—promotes the examination of potentially “fossil” human-climate relations, of cataloguing, articulating, and engaging with coupled climate and societal change not encountered in vivo anymore. The deep past of the Pleistocene truly is a “foreign country” (cf. Lowenthal, 1985) and its analysis may expose how past humans—including other hominins with varying biological make-up and possibly alien climate exposures—have dealt with nonanalogue environmental challenges and climatic oscillations of magnitudes and amplitudes that defy our latter-day experiences (Figure 2). The latitudinal study of these alternative ways of being human and the attendant long-term socioecological coping strategies may help to inspire new forms of climate engagement and may contribute to a transformation in the way we think and conceptualize the human–climate nexus. That said, the archeological deep-time record of the Pleistocene is also a dark mirror cautioning against overly optimistic perspectives of the future.

The Paleolithic (ca. 3.3 million to 11,800 years ago)—despite its pervasive mischaracterization as a static period of slow human becoming—harbors plentiful evidence for innovative and diverse biocultural evolution (Gamble, Gowlett, & Dunbar, 2014). It is also fundamentally characterized by recurrent demographic fluctuations, sometimes sweeping genetic bottlenecks, extinctions or near-extinctions, failed socioecological experiments, and abounding biological and cultural replacement (Bar-Yosef, 2017). The complex story of early human dispersals out of and back into the African continent is a good example here. A palimpsest of processes has created a mosaic of material signatures indicative of many dead ends, abandoned pathways and the evolving dialectics among population expansion, retreat, and fragmentation (Dennell & Roebroeks, 2005; Stiner & Kuhn, 2006). Although this migratory deep history of the human species was undoubtedly mediated by the climate envelope in which it was enfolded (Eriksson et al., 2012), the archeological
record offers a cautionary testimony that technology could not always provide the solutions required. This dark side of Pleistocene human–climate relations is also exemplified by the Last Glacial Maximum (ca. 25–18,000 years ago)—a period of severe climate cooling and atmospheric dust accumulation—which had a strong global impact on contemporaneous ecosystems and human populations. As a result, Central and Northern Europe were practically abandoned over millennia (Banks et al., 2008) and human–environment articulations substantially reshuffled (Box 2).

The deep time panorama of early human dispersal and environmental coping suggests that varying hominin biocultural adaptations had differential and long-term effects on climate tolerance, habitat preference, vulnerability, and resilience (e.g., Burke, Riel-Salvatore, & Barton, 2018; Erin, 2012). Periods of climate amelioration—warmer, cooler, wetter, or dryer conditions, all relative to who is responding to them—are often portrayed as “windows of opportunity” in the archeological and geoarcheological literature (e.g., Rosenberg et al., 2011). These climatic changes have been demonstrated to modify the push-and-pull dynamics for hominin paleo-biogeography and to provide a suite of

**FIGURE 2** Global climate record of the last 3 million years and key events highlighted in this paper (logarithmic timescale): (pink curve) ice-volume variation as a proxy for global temperatures recorded in the so-called “LR04” stack of benthic ocean floor δ18O (Lisiecki & Raymo, 2005); (1) Holocene–Pleistocene transition (ca. 11,800 years ago); (2) Last Glacial Maximum; (3) Eemian Interglacial (MIS 5e); (4) Middle Pleistocene transition (ca. 1.25–0.7 million years ago); (5) Holocene warming trajectory; (6) high amplitude climate variations within the last 1 million years; (7) Pleistocene cooling trend. Note that around 1 million years ago, climate regimes transitioned from 41,000 year-cycles to 100,000 year-cycles with increasingly rapid climatic oscillations between colder and warmer periods

**BOX 2 Pleistocene Archeology: Time Depth, Material Culture and Hominin Protagonists**
Pleistocene archeology addresses the origins and early evolution of the hominin tribe, including our own taxonomic group—*Homo sapiens*. It covers the timeframe from ca. 3.3 million years ago, from the appearance of the first stone tools over the onset of the Pleistocene period—the Ice Age—to the beginning of the Holocene warm period, ca. 11.8 thousand years before present (cf. Figure 1). Pleistocene archeology examines the ecology, behavior, and culture of nonliterary, presedentary hunter–gatherer–fisher societies, and encompasses the vast majority of human history (>96%). The discipline is uniquely positioned to investigate the long-term coevolutionary dynamics between biological and sociocultural adaptations of our hominin relatives, such as the interlocking of physical stature, brain capacity, and tool behavior. The iconic material culture of the Old Stone Age—the period Pleistocene archeologists are mainly concerned with—is made up by sharp-edged stone implements used for varying purposes. Pleistocene archeology deploys an array of state-of-the-art laboratory methods and relies on zooarcheological analyses as well as the study of organic technologies and artistic traditions, yet its empirical backbone consists of the spatial and temporal distribution of different stone artifact assemblages. Pleistocene archeology now adopts a multispecies perspective, taking stock of the significant evolutionary diversity of hominin protagonists and their relations to other species; it investigates a timeframe in which multiple hominin phenotypes—some of which were only recently discovered (e.g., Denisovans, *Homo floresiensis*, *Homo luzonensis*, *Homo naledi*)—variously coexisted across the Old World, and how these species fared vis-à-vis the changing climate regimes of the pre-Holocene.
exploitable, positive climatic affordances for mobility and adaptation, including the provision of regional refugia which can serve as favorable dispersal hubs (Dennell, Martinón-Torres, & Bermúdez de Castro, 2011; Stewart & Stringer, 2012). Climatic “windows of opportunity” also afforded—as they do today (Birkmann et al., 2010)—the potential of major societal change.

By the same token, a key lesson seems to be that climate is more important in limiting rather than enabling hominin expansion and biocultural change (Brooks et al., 2005)—climate “forcing” tends to amplify obstacles instead of widening the possibilities of action (Gamble, Davies, Pettitt, & Richards, 2004). Examples include the diversification of hominin behavioral trajectories between Marine Isotope Stages (MIS) 5 and 3 (ca. 150–30,000 years ago) in Africa (Scerri et al., 2018), the pronounced range shifts of anatomically modern Homo sapiens populations during and after the Last Glacial Maximum (ca. 20–11,500 years ago) in Europe (Verpoorte, 2009) and the pattern, tempo, and macro-evolutionary timing of hominin extinctions throughout the Pleistocene (Foley, 1994). The last point draws attention to the frequently underappreciated circumstance that contemporary humans are the last remaining descendents of a highly variable lineage of hominin phenotypes, most of which developed extremely successful and long-lasting biocultural adaptations to the severe and unstable climates of the Plio-Pleistocene (Foley & Gamble, 2009), but which disappeared alongside a range of other once-prolific large animals. While the space of hominin socioecological evolution may appear finite, the documented adaptive strategies of these hominin lifeforms and their various technologies of climate-change buffering do exhibit great latitudinal and temporal mutability and thus also frame a scenarios-space of different behavior–biology–ecosystem articulations, which can provide foundational insights into nonanalogue socioecosystem adaptations of the near and far future (Fox et al., 2017).

This approach to past climate relations, unique to Pleistocene archeology and the pEH, lays out new pathways of thinking about climate change and assessing the possible impact of the novel ecosystems and radically altered climate regimes that will characterize our Anthropocene future. The evolutionary legacy of our species can issue basic lessons about the long-term consequences of various modalities of climate engagement and provides compelling new opportunities to explore the interplay of human biology, behavior, and material culture in coping with the extremes and saliences of a changing climate–environment nexus. The quintessential representatives of a sister humanity, the Neanderthals, illustrate some of the issues and opportunities of pEH concern: the classic body plan of Eurasian Neanderthals is thought to have evolved in the early phase of the last glacial cycle, shortly after the termination of the Eemian interglacial (MIS 5e; ca. 130–115,000 years ago), a period broadly analogous to the Holocene (Churchill, 2014). There is an ongoing controversy about the ecological significance of classic Neanderthal physiology, with proponents of the traditional cold-adaptation hypothesis (Holliday, 1997) pitched against those who advocate a temperate/Mediterranean core niche envelope (Benito et al., 2017; Carrión et al., 2018) backed by supporters of a temperate woodland-adapted biomechanical system (Stewart et al., 2019). The overall spatiotemporal pattern of “Neanderthalization”—the gradual proliferation of diagnostic morphological Neanderthal traits—coupled with the recent discovery of deep regional population structures based on aDNA evidence indicates complex and geographically structured evolutionary trajectories within the Western Eurasian Neanderthal lineage (Fabre, Condemi, & Degioanni, 2009). These were catalyzed by different ecosystems and climate regimes yet modulated by a set of biocultural predispositions tied to high-amplitude climate shifts including the extremely cold stages between MIS 7 and 5. As a result, the specific biocultural suite of adaptations we commonly refer to as “Neanderthal” is probably misunderstood as a direct, unequivocal response to a single climate envelope, but rather emerges as the long-term product of climate uncertainty and climate novelty. The archeological signature of increased techno-economic flexibility in Neanderthal stone working methods and tool-use strategies supports this conclusion (e.g., Meignen, Delagnes, & Bourguignon, 2009).

The implication is twofold: first, Neanderthals and other hominin phenotypes prospering in broadly the same temporal interval should be critically re-evaluated as possible deep-time epitomes of coping with radical ecosystem variability, climate upheavals and attendant environmental permutations. The successes and failures of these hominins might then hold some important clues for our own future, where the major challenge is most likely not to adapt to a single, unprecedented human-made climate–environment nexus, but to promote ways of living under unstable and to a certain extent unpredictable climate conditions. Second and somewhat ironically, issues and questions prompted by the Anthropocene may motivate new ways of thinking about these long-vanished hominins and their archeological residues. Neanderthals in particular had to serve as a mirror for our own foibles since their discovery (Roebroeks & Soressi, 2016) and perhaps they can also be used to re-think our contemporary and future relations to climate and the environment.

The juxtaposition of climate trajectories and patterns and processes of biological adaptation and material culture change in early human evolution generally reveals that regime shifts, rather than specific climate envelopes, are key
agents in human origins. Potts’ (1998) classic study of linkages between net climate variability and generalized rates of biocultural change in hominin evolution has shown that the defining characteristics of our species, such as encephalization, toolmaking, and global expansions developed in conjunction with shifting frequencies, periodicities, amplitudes, and rates of climate change (Grove, 2011). From a macro-evolutionary perspective, therefore, the grand panorama of human becoming appears to be framed by long-term cycles and patterns of cooling, aridification, humidification, and warming (Potts & Faith, 2015). Pleistocene archeology delivers a timely reminder that some of the most consequential changes in climate that early humans experienced operated on temporal scales outside of the grasp and certainly beyond the “perceptual span” of individuals or even generations (cf. Hassan, 2009).

While long-term climate constellations and accumulating regime dynamics are more likely to inaugurate long-lasting and irreversible evolutionary pathways, medium and short-term climate fluctuations, rapid event-like climate change as well as extreme occurrences such as the super-eruption of the Toba volcano on Sumatra ca. 74,000 years ago (Clarkson et al., 2020), the Campanian Ignimbrite eruption in the Mediterranean ca. 40,000 years ago (Fedele et al., 2007) or the outburst of the Laacher See volcano ca. 13,000 years ago in Central Europe (Riede, 2017b) have the demonstrated potential to initiate abrupt and sweeping cultural reactions, to precipitate rapid societal transitions and to make their way into the collective memory of the affected populations and their neighbors. As already noted by Hassan (2009), these latter climate change modalities are more likely to be remembered and can incite conscious and strategic climate change engagements, yet the archeological signatures they leave behind tend to differ markedly from interactions with millennial-scale climate systems.

It remains an open question—to be explored comparatively in the future—whether, when and to what extent past hominin groups would incorporate climate experiences into longer-term population-level social and technological strategies. McNabb (2005) has for example proposed that the notable stability of the handaxe-centered Acheulean technocultural phenomenon across Africa and Europe (ca. 1.8 million to 300,000 years ago) may be interpreted as an expression of higher-order behavioral strategies to cope and deal with remembered periodic shifts in local aridity, providing hominins with the required flexibility to repeatedly adapt their versatile technical repertoire to local conditions and tap into exaptive possibilities if necessary (sensu Andriani & Cohen, 2013; Larson, Stephens, Tehrani, & Layton, 2013). Pleistocene archeology thus offers a range of scenarios for exploring how short-term yet frequently extreme and compound climate events interfered with long-term climate trajectories and how the ensuing coupled dynamics affected hominin technology, material culture, and niche construction.

The vast purview of intricate, multitemporal intercalations of Pleistocene climate and environmental change with peopling and re-peopling processes and hominin population expansions and retractions on both local and global scales also provides the hitherto neglected opportunity to critically investigate the sociocultural appropriation of newly encountered constellations of climate, landscape, and environment. Archeological research on landscape learning (Rockman, 2009) and environmental legibility (Guiducci & Burke, 2016) is of key importance here. This work yields novel insights into those episodes where past humans expanded into unfamiliar territory or where their ambient territories became unfamiliar due to climate change (e.g., Hiscock, 2014) and paleoarcheologists are in a chief position to examine in detail how humans in the long-run—under varying social and material conditions—learned, or failed to learn, previously unknown local and regional climate conditions. Since we possess no suitable present-day analogue to study such processes of “climate learning” and the various factors that influence and possibly promote them in vivo, the insights and deep-historical lessons distilled from such analyses might inform future scenarios of human–climate interaction where humans likely have to once more cope with de novo climates.

The lessons of pEH may be largely allegorical, but they feed strongly into the potential role of Pleistocene archeology in critiquing tenacious yet frequently flawed narratives of strong climate determinism or climate irrelevance in deep human history and beyond. Although climatic processes are vicarious obstetricians and pacemakers of culture change and evolution, the long-term consequences of past climate alterations were typically relational and almost always dependent on the specific interplay of climate variables—both emic and etic—with the make-up and ecocultural inheritances of the societies in question (cf. Pillatt, 2012). The archeological record of Western Europe, spanning the later part of the Middle Paleolithic as well as the Upper Paleolithic (ca. 60–15,000 years ago), with its many rich, well-documented and high-resolution sites and its long history of research provides a nonanalogue model-sequence to explore such long-term effects and interactions of disequilibrium dynamics, path dependencies and sociotechnical pre-configurations including niche construction vis-à-vis climate change and environmental instability. The culmination of decades of paleoarcheological research and new synthetic work strongly indicate that the classic phasing and sub-phasing of the European Upper Paleolithic—comprising transregional techno-complexes such as the Aurignacian and Magdalenian with regionally varied articulations of early, middle and late stages—reflects a nested, long-term evolutionary pattern of
successive patches of socio-material coalescence, consolidation/rigidification, and destabilization/decline (Audouze & Valentin, 2010).

These developments are perhaps best reflected in the gradual reorganization of object assemblages, especially lithic toolkits, the formation and demise of particular stylistic regimes, and the evolution of social networks and systems of mobility (e.g., Klaric, 2013; Langlais et al., 2016). These millennial-scale trajectories suggest that these Upper Paleolithic techno-complexes, which tended to persist for several millennia, may reasonably be interpreted as evolving human (ecological, cultural, and cognitive) niches with their own regime dynamics and logics of development, rooted in incrementally constructed and adjusted material worlds, know-how and knowledge spaces as well as cosmologies and cultural ontologies. The niche dynamics fostered by these long-term trajectories consequently produce very different climate expositions and generally mediate and transmute the responsive flexibility and vulnerability of human societies in the face of climatic and environmental change. Some of the observable long-term patterns are indeed compatible with the predictions of path-dependency theory: with increasing evolutionary path depth, the transaction costs of leaving the path become increasingly higher and to retain lateral adaptive flexibility is therefore more and more difficult (cf. Desmond, 2017; Martin & Sunley, 2012). The result, echoed archeologically in major technological transitions, is the inability or unwillingness to maintain the socio-material path, leading to its de-stabilization—variously catalyzed, prompted or amplified by climate change—and the gradual crystallization of new cultural evolutionary regimes.

This reconstruction of long-term change in the Late Pleistocene not only indicates that the distant past can have a disproportional effect on future adaptive options, it also suggests that we should pay closer attention to the admittedly difficult analysis of the architecture and design of the various possibility spaces underlying and regulating human climate change responses. Although the long-term adaptive and interactive implications of particular developmental choices or consequences for human societies are difficult to gauge or even predict, Pleistocene archeology offers the only available lens to directly study the impact of divergent millennial-to-decadal scale cultural evolutionary trajectories on the ability of human populations to cope with ecological perturbations and climate novelties. The mission statement of the pEH—by synthesizing the available deep-time evidence on nonanalogue human–environment interactions and fostering a future-oriented dialogue between paleoenvironmental scientists and humanities scholars—is thus to move beyond the analysis of adaptation and failure in the face of climate change, and to work towards a basic science (Grundlagenwissenschaft) of interacting historical, socio-material, and ecological regimes for developing an integrated conceptual framework of human–climate relations.

5 | IMPLICATIONS AND RESPONSIBILITY OF AN “ECO-CRITICAL” ARCHEOLOGY

We here point at major convergences towards concerns of contemporary relevance vis-à-vis climate change between the environmental humanities (Boggs, 2016), Critical Physical Geography (Lave, Biermann, & Lane, 2018), Historical Human Ecology (Crumley et al., 2015), paleoecology (Rull, 2014), and archeology (Contreras, 2017; McCorriston & Field, 2020; Riede, 2019a): humans and their actions upon, and beliefs about, the environment matter profoundly. There is now a host of rich datasets available for scrutinizing the constitutive dynamics of the human–climate nexus across variable temporal and spatial scales. By the same token, the claim to acute contemporary relevance of these perspectives comes with ethical implications of making them relevant also for stakeholders within and outside of the scientific community. Although hitherto marginal to, on the one hand, the environmental humanities and, on the other, major policy-influencing efforts such as the Intergovernmental Panel on Climate Change reports, an archeology that is aware of the indirect but no less important contribution of its narratives vis-à-vis contemporary climate quandaries—a reflexive “eco-critical” archeology—stands to make major contributions: archeological narratives easily enter public consciousness and form part of potentially actionable social capital, as demonstrated, for instance, so powerfully when narratives of the past were weaponized as part of totalitarian propagandas (Arnold, 1990; Díaz-Andreu, 2007). The discursive potency of the latter has again attracted attention in relation to dubious and damaging attitudes by “alt-right” supremacists (e.g., Hakenbeck, 2019), attitudes which have also been shown to correlate significantly with climate change skepticism and denial (Forchtner, 2019). The capacity to shape public imaginaries and to influence the stock of social capital, however, can also be deployed to make archeology work in favor of climate action so widely called for today.

While rooted in archeology, the pEH perspective aspires to be more than environmental archeology. It bundles approaches that, while maintaining the methodological alignment with the environmental sciences, seek to extend the
sensibilities, questions and methods of environmental history, and eco-criticism (Heise, 2006; Hiltner, 2015) into the deep past in order to craft new, politically and theoretically conscious and strongly evidence-based narratives of past human–climate interactions that hold the potential to imagine both past and future in new ways. It urges us to eco-critically re-read and re-frame the narratives produced by archeologists about the deep past in light of climate change concerns. It also makes room for new alliances between the historical sciences and future-oriented perspectives in the sciences and humanities. In so doing, the pEH not only add valuable long-term data on ecological baselines and processes but also help to recover the long-lost experience of climate relations from our ancestral past. Granted, deep historical datasets are often poorly resolved and highly fragmented but they also facilitate a salubrious tacking between temporal and spatial scales from the minute to the massive (Gamble, 1999), creating many points of contact with other disciplines and perspectives. Finally, such perspectives also mitigate against naively progressivist as well as unannounced apocalyptic future-making agendas often based on ahistorical or “shallow-time” perspectives.

Often reported in newspapers and popular science media, equipped with a large array of dedicated museums and underwritten by a vigorous research community, archeology benefits from its often contested but overall highly visible role in the public sphere and can make a real difference in how the story of human–climate engagements is told. Museums of culture history regularly figure among the most visited attractions and museums in general have repeatedly been shown to be powerful platforms of engagement and discourse, also with climate change, albeit so far with strong bias towards natural science museums (Cameron, Hodge, & Salazar, 2013). If we accept, as argued by many before us (Hambrecht & Rockman, 2017; Van de Noort, 2013), that cultural heritage must also be integrated and considered in the broader climate change debate—both as victim and as part of the solution—then museums of culture history may serve as “provocateurs” (Cameron, 2019, p. 647) and “catalysts” (Rees, 2017, p. 166) of societal change and alternative futures. The adoption of overt attitudes to climate change would, however, require a more widespread acceptance among archeologists that their work is intertwined with ethical and political debates and that the boundaries between activism, advocacy and academia are carefully to be re-negotiated.

The “eco-critical” re- framing of archeologies of the deep past that we suggest here provides a number of opportunities to realign archeological inquiry with discourses in the environmental humanities. It would also strengthen critical theory and thought within human origins research. An eco-critical archeology takes the relationships that human beings develop and uphold with their natural environment as its fundamental point of departure. Yet it would investigate them through the prism of the environmental imagination. While examining the intersection between material culture and the wider “archaeosphere” (sensu Edgeworth, 2018) with past environments and climates, this archeological eco-criticism is forward-looking. It seeks to forge new connections between archeological knowledge spaces—metaphorically and in the form of actual sites and monuments—and the present and emerging future. It recognizes the natural world not merely as an object of study or something to be transcended but as inherently significant. It emphatically turns the lens back on itself in asking how human–nature relations are conceived and imagined by archeologists themselves and whether alternative narratives and imaginaries are possible. This analysis not only requires the careful exposition of research-historical and theory-laden imports underwriting archeological studies of human–environment–climate relations. It also requires a renewed interrogation of the interweaving of nature and climate conceptions with the broader politics of science in archeology and beyond. Paralleling Glotfelty’s (1996, p. xviii) portrayal of eco-criticism, archeology qua pEH then transpires to be a genre of backward-looking but future-oriented, evidence-based nature writing, acknowledging that archeological literature plays an important role in the environmental imagination of our time.

In general, the ambition of the pEH is to broaden, enrich, and deepen the conceptual repertoire of paleoarcheologists and to open it up for discussion across the environmental humanities. Pluralism in approach, theory, and narrative is embraced, covering the entire spectrum between “realist” and “constructivist” approaches to human–nature relations (cf. Heise, 2006) and pooling resources from data-scientific and strictly interpretive research angles. As such, the pEH are a multidisciplinary field in-the-making, earmarked by intellectual inclusivity and open-endedness without losing touch with the empirical past. By acknowledging its own situatedness in this intellectual landscape, the pEH approach encourages a celebration of epistemological diversity in human–climate research. It also encourages an active contribution – through teaching, research and mentoring—to the making of the “ecological university” (Barnett, 2011; Wright, 2017) and the “slow hope” (Mauch, 2019) of the intergenerational change in a shared planetary future that it offers.

Archeology lends itself as an anchoring discipline for this larger enterprise due to its long-standing position at the interface between the environmental and climate sciences on the one hand and the social sciences and humanities on the other. As a deliberately multidisciplinary, hybrid, and multiparadigmatic project, the pEH do not seek strong commensurability or even knowledge unity. The endeavor is rather to encourage educated, self-conscious multivocality and
to work towards “thicker,” more consilient understandings of past human–nature intersections which acknowledge the complexity, dynamics, and multifaceted nature of the involved relationships. The empirical, interpretive, and narrative “thickness” that the pEH pursue derives from the creative potential emerging from drawing together powerful, data-driven methods and approaches from the paleosciences and the ethical awareness, reflexivity, sensibility, and narrative competence of ecologically invested cultural studies and humanities perspectives. For this project to succeed we must arguably grant rigorous but interdisciplinary epistemological exploration more space in the research landscape, as the coordination of scientific and humanistic observations and perspectives is not simply a pragmatic problem but requires exercised (and taught) awareness, intellectual diligence, and mutual respect.

To this end, the pEH table some new incentives to re-think the relationship between different disciplinary specializations and research traditions within archeology vis-à-vis human-climate relations in the deep past. As exemplified by the Pleistocene case studies sketched out here, different academic traditions—underpinned by national research trajectories and politics of knowledge formation—have developed varying sets of know-how and expertise with respect to the study of human-clIMATE interactions in the past. French paleoarcheological techno-anthropology has, for example, developed a unique, mostly qualitative toolkit to expose the internal dynamics of evolving technical systems and is well-situated to chart deep-historical pre-configurations, preadaptations and path dependencies, while British and US American paleoarcheologies have developed strong and often quantitative tools for elucidating past adaptations, strategic choices, trade-offs, and flexible material culture responses in the face of ecological uncertainty and transformation. Australian archeologists have recently begun to investigate the durability of cultural memory over millennia (Nunn & Reid, 2016) and to link changes in the physical landscape to notions of place and country, opening up the exciting avenues for recovering fragments of deep-historical climate experience and knowledge.

In closing, we propose the pEH as a disciplinary realignment to provide archeologists and allied paleoscientists, but also different voices within deep-time archeologies, with novel incentives and arguments to contribute to the climate question. It would allow such archeologists to profit from the “environmental turn” of the humanities and social sciences, while emphasizing the benefits of integrating archeological perspectives and insights into environmental humanities discourses. We have offered a richly referenced perspective on how the pEH may be situated amongst related fields, and how it complements and enriches them. We hope that readers in archeology but also in neighboring fields—in both the natural sciences and the humanities—will find, if not answers, then at least inspiration and pointers to additional reading, exploration and reflection. If successful future-making depends on our ability to navigate environmental novelty and climatic instability in the long-term future, the millennial-scale dynamics of human–climate relations of the deep past provide a salubrious source of guidance, inspiration, and warning.

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