Marcos André Torres de Souza
Diogo Menezes Costa *Editors*

Historical Archaeology and Environment

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Preface

In the beginning of 2015 the germ of this book was born when the authors discussed the possibility of a work that converged the actual debates about new materiality interpretations in the historical archaeology field and the contemporaneous environmental impacts caused by human actions on the future of the world. Following this, the authors proposed a symposium to be held at the Congress of the Society of Brazilian Archaeology (SAB) in that same year to commemorate the 35 years of social development in the city of Goiânia. The symposium, entitled "Historical Archaeology and the Environment," congregated seven presentations distributed along three axes of discussion focused mainly on the South American perspective. We were fortunate and honored to have had as a debater Alfredo González-Ruibal, one of the speakers invited to the event. The good acceptance of the debate by the public and the great synergy among the speakers convinced us that this was indeed a hot topic of discussion and that more work needed to be done on it.

The second stage was the book organization itself, which incorporated the papers already presented during the symposium as a base, with the inclusion of works by new invited authors. At this time, the book's scope and coverage were regional, but changes happened and the project reached an international level. As the major publications in the area of environmental archaeology were about pre-history, the "timing was right" and the diverse contributions received in this edited volume were the proof that the idea of Ecoarchaeology works.

We would like to thank you our colleagues Matt Edgeworth (University of Leicester), Stephen Mrozowski (University of Massachusetts Boston), Patricia Fournier Garcia (ENAH)), Tim Murray (La Trobe University), Rafael de Abreu e Souza (Unicamp), Julio César Rubin de Rubin (PUCGO), Marcos Leitão de Almeida (Northwestern University), Alicia Caporaso (Bureau of Ocean Energy Management, BOEM), Daniel Warren (Oceaneering Survey Services), Stephen R. Gittings (NOAA Office of National Marine Sanctuaries), Susan Lawrence

(La Trobe University), Peter Davies (La Trobe University), Andrés Zarankin (UFMG), Melissa Salerno (CONICET) and others colleagues that for unforeseen reasons did not participate in this volume but helped it to happen on many levels.

Belém, Pará, Brazil — Diogo Menezes Costa
Rio de Janeiro, Brazil — Marcos André Torres de Souza

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Introduction: Historical Archaeology and Environment

Marcos André Torres de Souza and Diogo Menezes Costa

Abstract The creation of this volume was motivated, on the one hand, by the lack of available studies involving the environment in historical archaeology and, on the other, by the dramatic climate changes that are occurring across the planet and the global efforts to face them. With this in mind, our intent was to offer new thoughts on the subject and, by doing so, contribute to the development of new approaches, debates and bodies of knowledge that involve historical archaeology and environment.

In this introduction, we also hope to update the discussions and approaches that may be helpful to those debating this topic. As we understand it, an array of new forms of knowledge is emerging in the discipline that might be potentially relevant to our interests. Following an historical archaeological approach to environmental changes, all the chapters deal with the main issues relevant to this discussion, including (1) theoretical and methodological approaches to the environment in historical archaeology, which intend to offer innovative and substantial analytical venues for the study of the environment through the lens of historical archaeology; (2) studies on environmental historical archaeology, which include a range of case studies that demonstrate how the human–nature relationship has evolved historically and globally; and (3) historical archaeology and the Anthropocene, where we found studies of environmental changes and the impact of human activity on the environment that affect us today and will continue to so in the future.

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1.1 Transposing Frontiers in Historical Archaeology

The development of debates involving the environment has been connected to a variety of epistemic and ontological issues. As has long been noted (Deagan 2008 [1996], p. 24; Hardesty 1999, pp. 51–52; Mrozowski 2006, p. 24), the lack of interest in the environment in historical archaeology has been related to the understanding that the modern world has increasingly distanced human beings from the natural environment, mainly because of a greater dependence on modern technology and market economies. In his influential work *In Small Things Forgotten*, James Deetz (1977) presented arguments that have become emblematic of this line of reasoning:

> This lessened dependence on the natural sciences is but a reflection of the role played by the natural world in the history of human development. The earlier in time one goes, the more directly and intimately tied to the environment, so that such disciplines as paleontology and geology are essential to the proper understanding of life in the distant past. As culture became more complex, we were further removed from the natural world. Since Historical Archeology deals only the past few hundred years of our multimillion-year history, it follows that this last, brief time would find us at our greatest remove. (Deetz 1977, p. 22)

In historical archaeology, this kind of perception articulates itself with different interconnected dualities. At a more fundamental level it is related to the view of the historical period as a compartment distinct from prehistory. In the construction of the concept of prehistory the native and "wild" were placed into a distinct discursive field. Thus, they became a legitimate other, linked to a diverse temporality and associated with primitive and natural modes of existence (Kehoe 2013; Lane 2013; Lucas 2005, pp. 121–126, Matthews 2007; Mitchell and Scheiber 2010). When historical archaeology was established as a field of study in various parts of the

Americas during the 1960s, it focused on a previously established time interval that existed in contrast with prehistory. Methodological differences contributed to reinforce this division, inasmuch as the documentary records, systematically incorporated into historical archaeology, had been established long before as one of the defining features of the associations between nature and speech, on the one hand, and writing and culture, on the other (Derrida, cited in Luke 2005, p. 124).

The type of analysis carried out by historical archaeologists has contributed little to the incorporation of the environment in our studies, since we have dedicated ourselves predominantly to the investigation of the so-called "social landscape." As established in the United States in the 1970s and 1980s, this type of analysis was based on the principle that past landscapes were created through human agency and could play an active role in the mediation and legitimation of social relationships (Deetz 1977, 1990; Kelso and Most 1990; Leone 1984, 1989; Rubertone 1986, 1989). Based on this notion, streets, squares, gardens, cemeteries, battlefields and buildings began to be studied in order to reveal past worldviews, social order, symbolic meanings, power relations and inequalities, identities and memories. Primarily driven by the post-processualism, this kind of approach has largely dominated landscape analyses in historical archaeology (for a review of these studies among American scholars, see Branton 2009). It is useful to note that this approach, which focuses on human ingenuity and intentionality, has contributed to reaffirming the triumph of culture and civilization over nature, and ultimately of modernity and Western principles. In this approach, the landscape is linked to the intentional world of humans. It is submissive to its will and passions, leaving behind, with very rare exceptions, what has been called the "natural world." This approach also reinforces the differences between historical and prehistorical times. The post-processual agenda certainly contributed to this, insofar as it militates against the positivistic approaches often employed in the study of prehistoric sites, which repeatedly attribute to the natural world qualities capable of complicating or limiting human activity (Anschuetz et al. 2001, pp. 174–175).

This constitution is related to the application of certain concepts, which affirm this dual organization. For the examination of places, spaces and human surroundings, historical archaeology has adopted the concept of landscape as distinct from that of the natural environment, the former being considered as a product of the structuring of cultural practices and as subject to human subjectivities (Anschuetz et al. 2001, p. 160; Johnson 2007, pp. 3–4; Knapp and Ashmore 1998, p. 6; Ucko and Layton 1999, pp. 3–4). On the other hand, if this lack of attention to nature in historical archaeological studies—also called in the period "text-aided" archaeology—reflected an occidental view of the dichotomy between history/prehistory or written/unwritten societies (Little 1992; Andrén 1998; Hall 1999), today natural studies in historical archaeology are also conducted more in a "scientific" than "historical" manner, following a processual method where many environmental issues are investigated only with regard to their physical and chemical proprieties, rather than culture–nature relationships.

1.2 Beyond the Nature/Culture Division

Studies involving the social landscape have made a remarkable contribution to historical archaeology. However, they have as a limitation the creation of analytical constraints for those interested in debates about environment and its multiple relationships with humans. If we intend to rethink the divisions presented above, which are above all ontological, it is necessary to reformulate the way we view our relationship with the environment. A case study by Tilley et al. (2000) that involved the investigation of an earlier time period can be useful here. In examining the case of Hilltop Tors in South West England, where there is a massive presence of bolder and rock spreads known as *clitters*, these authors have deftly anticipated our current debates. As they pointed out, *clitters* are partly natural, inasmuch they are formed by complex geomorphological processes, and partly cultural, inasmuch as they were arranged by the inhabitants of the region for various purposes. Hence, the initial aim of the authors was to identify what was natural and what was cultural in these formations. Despite their great technical knowledge, they faced immense difficulty in this task, especially because both natural and cultural processes are dynamic and may intermesh, forming a mixture that can be extremely difficult to separate. They addressed this issue by arguing that these stones defy our understanding of "cultural" and "natural," since, as collectives, they are ambivalent. In this sense, they are culture–nature hybrids. They are in the same "envelope" and for this reason will be better understood if thought of as being simultaneously *in* nature and *in* culture. In this way, the struggle to determine what is cultural or what is natural in these stones can be thought of as a pseudo-problem.

Though this analysis was carried out on an infinitesimal scale, it can be projected to a global scale; and at this point it may be useful to return briefly to Deetz's premise. According to its logic, you, the reader, may be at this very moment removed from nature. This is because you may be in front of an eBook reader, in a closed room, using artificial light, surrounded by objects and with the air conditioning on. However, if we take into account Tilley and his colleagues' arguments, while you are *in* culture you are at the same time *in* nature, because the energy that feeds the computer and the lamp you are using is generated by force generated by the environment, (e.g., water or wind in the case of a wind turbine or a fossil fuel in the case of a generating plant) and as such related to it, albeit remotely. In the same way, the chair that you are using, as well as the other objects that surround you, comes from a variety of natural sources. If you happen to be using air conditioning, then that exchanges heat with the external environment, contributing to an increase in temperatures in the city where you live. As eloquently demonstrated by Tilley and his collaborators, there is no irreducibility in a purely "cultural" or purely "natural" artifact, and this logic also applies to this case. Culture and nature are embedded in envelopes, at different scales and at different levels of correlation. Even environments that appear to be purely cultural remain connected to nature in a profound way. This happens especially because the number of connections between humanity and nature are far greater than we usually consider (Hodder 2012, 2016).

Part of the challenge of incorporating the environment in this perspective is the need to level different entities. This task has been driven by post-humanist perspectives. Such approaches, confronting the Cartesian dualisms that have been affecting our world view, have had increasing relevance in archaeology (González-Ruibal 2007, 2012; Olsen 2003; Shanks 2007; Webmoor 2007; Witmore 2007). For this volume, we are especially concerned in deconstructing an anthropocentric view of the world, as well as undoing the radical division between culture and nature (González-Ruibal 2007, p. 285; Mrozowski, this volume). This perspective, which has been strengthened by new and powerful approaches involving materiality and is equally imbued with an interest in symmetry, proposes to reflect on humans and nonhumans in their hybrid constitutions. Through systematic investments in empirical and scientific knowledge, it seeks to explore many of the intrinsic qualities of different entities, viewing them not as mediators, but as participants (Gosden 2005; Hodder 2012; Knappett 2004; Knappett and Malafouris 2008; Kristiansen 2014; Olsen 2010; Witmore 2014). In such a way, new forms of studying environmental entities—for example, rivers (Edgeworth 2011), plants (Jones and Cloke 2008; Veen 2014) and animals (Overton and Hamilakis 2013; Witmore 2015)—have become possible.

Among the theories that have been adopted in these analyses is the actor-network theory (ANT). This is one of the most serious efforts to move away from an anthropocentric approach. This perspective seeks to explain the networks constituted by different agents—people, animals, things, objects and institutions—in their associations and relations. In this theory, humans and their communities are not in a position of primacy. Instead, they are treated symmetrically on an equal footing with other entities, all playing equally important roles in the construction of actor-networks (Callan 1986; Latour 2005; Law and Hassard 1999). A concurrent approach comes from the concept of *meshwork*, as suggested by Ingold (2011, pp. 63–94), which instead of focusing on the networks of connected points, is concerned with the lines, which for him are interwoven threads of life along which different entities flow, mix and mutate. A perception also developed by Ingold (2000, pp. 96–140) and that we consider useful in reformulating our view of the environment and its place in historical archaeology involves the idea of *inhabitants*, as opposed to what he termed *exhabitants*. He associates the latter with a traditional view that is usually adopted in debates about the "global environment" as a world in which we humans have surrounded ourselves, extending from where we are to the horizon, to the earth below and the sky above. From this perspective, people do not live within the world, but on its outer surface. Expelled to its outer surface, we have become *exhabitants* of the planet. Contrary to this notion, the concept of *inhabitant* implies the perception that world we live in is a zone of admixture and intermingling. This is because, wherever there is life and habitation, the interfacial separation of substance and medium is disrupted to give way to mutual permeability and binding. Perspectives of this order, we believe, may allow the suspension of what Webmoor and Witmore (2008, p. 57; see also Witmore 2007, p. 549) called "epistemology of bifurcation," an epistemology which distances us from the world and an enormous variety of entities, hitherto little considered in historical archaeology.

1.3 Environmental Historical Archaeology

Although studies of the so-called "social landscape" have dominated historical archaeology for decades, a number of pioneering works came out, demonstrating the relevance and potential of studies that involve the environment. (For a review of these studies, see Costa 2018; Deagan 2008.) Despite its constant updating, environmental historical archaeology has been understood as being concerned with the endlessly recursive relationships between people and their environments (Deagan 2008, p. 21) and includes examining a variety of interrelations, associations, impacts and transformations that happened over time in an effort to find a true *eco* prefix (Costa 2018).

We believe that the examination of these relationships can be sophisticated if one takes into account the developments involving the associations between the different entities. This is the case with the so-called "Gaia hypothesis," which considers the Earth as a living system, in which living and inorganic entities have evolved together into a self-regulating system, capable of affecting the chemistry and conditions of the Earth's surface (Lovelock 1979). Edgeworth in this volume presents new discussions about the concept of archaeosphere, whose propositions seem consonant to us with the idea of global systems formed by intermeshing spheres. As he considers it, the archaeosphere is a global-scale stratigraphic entity that can be defined as the totality of entities significantly modified by human activities. In his chapter, he examines the many active interactions, influences and impacts of this entity on other parts of ecological systems. Although partially created and transformed by humans, he sees it as having an independent existence.

It is our belief that through such perspectives, the analyzes involving human actions on the planet can be better investigated, allowing a renewed examination of their relations with animals and plants, as well as of elements such as global temperature, soil composition and deposition, atmospheric content, pollution, and so on. An example of the contribution of historical archaeology to this perspective comes from the study of the waterways that, formed by heterogeneous entities, may include, for example, water or mud, sun and the gravitational forces, which together power the hydrological cycle, and any structures built by humans. Taking into account this diversity of associations, of a fluid and dynamic nature, Edgeworth (2011, pp. 11–32; 2014b) argued that entities such as rivers are best regarded as entanglements of nature and culture.

A number of the works presented in this volume touch on rivers, oceans and water reserves, analyzing them through a variety of perspectives. In discussing the use of deep groundwater in Australia, Murray identified its implications in processes that include migration, stock movements, transportation routes and long-lasting impacts caused on the fragile ecology of the region. While Murray's work addresses water exploited for human use, Souza discusses the deliberate concealment of river waters in twentieth-century São Paulo City. In his study, it becomes clear how, due to a human desire to exercise control over nature, new and unforeseen reconfigurations in the culture–nature relationship can arise. In an analysis referring to an older Brazilian context, linked to the process of Portuguese colonization in central Brazil during the eighteenth century, Souza and Rubin demonstrated how rivers and other natural elements became entangled with different subjects through a series of collaborations. Following another direction, Caporaso and his collaborators combined different modes of scientific knowledge to demonstrate how materials from shipwrecks and benthic communities interact reciprocally in the Gulf of Mexico, co-evolving in a mutual manner.

It is in this same vein that environmental impacts can be understood. Callon's (1986) study in historical archaeology is particularly relevant. Perhaps the most obvious and well known situation involves the degradation caused by mining activity, which usually is extensive and sometimes has great temporal persistence (Hardesty 2001, 2010; Costa 2011). In this volume, Garcia studies charcoal production in the Mezquital Valley, Mexico. Her analysis demonstrates the profound imbrication between processes of colonial expansion and exploration and environmental degradation. A variety of other debates addressing the issue of environmental impact are presented in this volume. In examining the Amazon case, Costa demonstrates the close and inseparable relationship between colonial processes and this environment. As he notes, Amazonian environment is a hybrid formed in time through different temporalities and transformation processes. In the discussions by these authors, both nature and society appear transformed. This happens because, as has long been demonstrated by Callon (1986, p. 220), the identity and characteristics of the implicated actors—both human and nonhuman—as they are put into contact become capable of influencing each other.

In these analyzes it is of great interest how, in the modern world, individuals, institutions, practices and social strategies mingled with the planetary forces. There is a special place for historical archaeology in these discussions, insofar as in its trajectory, phenomena such as modernity, capitalism, colonialism and industrialization have been systematically scrutinized. In this volume, Mrozowski examines the accelerated commodity production that is commonly found in historical sites and its causal connections to climate change, taking into account some of the phenomena we mentioned above. In his chapter, he offers important elements for the creation of a renewed research agenda for studies in this area (see also Mrozowski 2006). In an analysis focused on extensive pastoralism in the arid zone of Australia, Murray follows a line of enquiry that is equally engaging. Through a multi-scale analysis, he reveals the connections of the pastoral enterprise with the global and regional economies, as well as the many environmental impacts related with this activity.

Whenever the environment is considered in studies developed by historical archaeologists, the diversity of human groups involved is notable, many of them enmeshed with histories of dispossession and displacement. The study of these relations has had an important penetration in the investigation of the demographic decline of native populations resulting from the European invasions in the modern world. For example, in a study involving indigenous populations in the Southwest of the United States and strongly supported by archaeological and paleoecological data, Liebmann et al. (2016) identified correlations among indigenous demographic decline, neotropical reforestation and shifting fire patterns on the regional level. In this volume, the reader will find other accounts of enmeshments, including not only indigenous populations but also African captives and fugitives, farmers, hunters, fishermen, cattle ranchers, miners and urban dwellers.

An important point regarding the study of these individuals from a symmetrical perspective has to do with the criticism that the principle of symmetry, when used, can distance us from power relations and the social factors (Preucel 2012, 2016), and we must highlight the relevance of these issues in the archaeology of the last decades, as well as the remarkable contribution made by the discipline in these debates. We understand in this respect that the innumerable entanglements between people and the world in which they live—and these include not only different entities, but also different types of individuals and interests—are heterogeneous. This struggle is constant, as is the emergence of the difference, which can effectively be revealed through the study of different kinds of associations (Callon 1986). An example of this type of situation is presented in the analysis of Souza and Rubin (this volume), which revolves around the constitution of power and ethnic networks on a Portuguese colonial frontier. As they have demonstrated, the construction of difference at this border was strongly tied to alliances established between humans and nonhumans. Beyond this discussion, and independent of the theoretical orientation assumed by the researcher in this type of analysis, we understand that historical archaeology has a valuable contribution to offer, allowing discussions on issues of great interest, such as environmental injustice, which is focused on the intersection between environmental quality and social inequalities. As formulated, this concept focuses on investigating how inequalities in power relations may imply, for example, in the unequal influence of certain groups over land use or the exposure of socioeconomically disadvantaged groups to certain environmental risks (Pellow 2000), which constitutes a line of reasoning that has been followed in historical archaeology for some time (e.g., Mrozowski et al. 1989; Shackel and Palus 2006).

Investigations involving the native conceptions of the culture–nature relationship, which in their organization may differ from Western ontologies, are a promising and yet incredibly unexplored path in historical archaeology, despite the existence of analytical avenues already open for this type of analysis, such as perspectivism (Castro 1996; Descola 1992). In this volume, Almeida discusses how the *Ficus Thonningii Bl.*, a native species of Central Africa, was used in the ritual for the foundation of new villages to establish the condition for engagement between newcomers and terrestrial spirits of newfound lands. Considering data drawn from archaeology, historical linguistics, cognitive linguistics and comparative ethnography, he moves beyond assumptions about the separation between humans and nature and mind and body, showing how a host of embodied practices and cognitive processes marked the tree as a central entity in local ideologies. As he observes, Central Africans have a relationship with the environment that cannot be explained by considering dichotomic organizations, which lead him to shift his view beyond Western ontologies.

1.4 The Anthropocene

The idea of the Anthropocene refers today to "a time interval marked by rapid but profound and far-reaching change to the Earth's geology, currently driven by various forms of human impact" (Zalasiewicz et al. 2017, p. 56). The term was proposed by the atmospheric chemist Paul Crutzen and the biologist Eugene Stoermer (2000) in order to designate a new geological epoch in which mankind plays a central role in the geology and ecology of the planet. After garnering acceptance, the Anthropocene was officially acknowledged by international scientific organizations. From 2009 it has been formally analyzed by the Anthropocene Working Group (AWG) at the International Commission of Stratigraphy in order to assess whether the Anthropocene could be considered a potential chronostratigraphic/ geochronologic unit and to determine whether it is sufficiently different from the Holocene Epoch of geological time (Zalasiewicz et al. 2017, p. 56). According to the latest information published by the AWG, the majority opinion within the group holds the Anthropocene to be stratigraphically real and that it must be formally recognized as an epoch (Zalasiewicz et al. 2017). Regardless of its official recognition as a geological time unit, it has gained increasing importance in different fields of knowledge, as there are already two journals dedicated to the theme: *Anthropocene* and *The Anthropocene Review*. In archaeology, its relevance was definitely established in a forum organized by Edgeworth (2014a). As he pointed out (Edgeworth 2014a, p. 75), archaeology can offer significant contributions to this study, with ideas and arguments (whether in support or in opposition), material evidence in the form of the archaeological record, against which specific arguments can be checked and evaluated, along with a tried and trusted methodology for doing so.

Among the many uncertainties surrounding the term *Anthropocene* is the establishment of its temporal limits. The tendency expressed so far by the AWG is to formally recommend an epoch/series rank based on a mid-twentieth-century boundary. This point of inflection, which marks the beginning of the so-called "great acceleration," refers to a moment in which an array of anthropogenic signals imprinted upon recently deposited strata became more clear and distinctive (Zalasiewicz et al. 2017, p. 57). Besides this date, which seems to be on the way to becoming official, there are others that would also be interesting to bear in mind. Some consider the Anthropocene as having a deeper origin in time (Lewis and Maslin 2015; Smith and Zeder 2013), an older date that serves as a milestone for some refers to the period corresponding to the so-called collision of the Old and New Worlds, beginning with the arrival of Europeans in the Caribbean in 1492 and which, though not considered often, seems to make sense in many colonized countries. This date is associated with large global processes, including large human population replacements; the development of global trade networks linking Europe, China, Africa and the Americas; and the resultant mixing of previously separate biotas, known as the Colombian Exchange (Lewis and Maslin 2015, pp.174–175). Another date, which for some time was considered as defining the Anthropocene, refers to the one originally proposed by Crutzen and Stoermer (2000, p. 17) and whose chronological frame is the later part of eighteenth century, which corresponds to the development of steam engine (1784), the massive use of fossil fuels to power the industrial revolution and the beginning of a growth in the atmospheric concentrations of several greenhouse gases. Although the AWG sets by the onset of the Anthropocene in the mid-twentieth century, it may be of interest to consider these dates as they associate with important Anthropocene precursors. How, for instance, can we dissociate phenomena such as the deforestation of the Amazon forest during the last 500 years (Costa, this volume) or northern Mexico during the colonial period (Garcia, this volume) from the great global forces that have, over time, made the Anthropocene turn into a global force of great magnitude? Even in environments where the idea of "pristine nature" seems to prevail, deep and often irreversible imbrications can be identified between the forces that now move the great global systems related to the Anthropocene and a past before the century of great transformation (see especially in this volume Costa, Lawrence and Davies, Zarankin and Salerno). As Lawrence and Davies (this volume) have pointed out, archaeologists know that the culture–nature entanglement is an ancient one and historical archaeologists have the capacity to situate recent action in that deep-time continuum.

As it spreads through the various fields of knowledge, the idea of the Anthropocene has been shown to be multifaceted. However, it is based on a crucial and shared understanding. From its origin, it refers to an Earth system based on the principle that its different constituents are involved in interrelated cycles where matter is continually in motion and is used and reused in various planetary processes. In this sense, the Anthropocene is not "the landscape," "the ecosystems" or "the environment." In this conception, humans appear as a "force of nature." Like the other great forces of nature, they determine the course of evolution (Hamilton 2015, p. 2). This idea of interconnectivity between humans and nonhumans comes close to current perceptions in archaeology and in other fields of social sciences. With a remarkable capacity for attracting the attention of researchers, it has even aroused the interest of influential scholars of our century (Chakrabarty 2009; Haraway 2015; Latour 2017; Morton 2016), which can potentially expand our repertoire of theoretical and analytical alternatives.

In this volume, two chapters touch directly on this theme. Lawrence and Davies review the work of archaeologists using environmental data and the work of natural scientists, producing data about environmental change over the past two centuries in Australia. They adopt a broad definition of the environment that encompasses earth systems and hydrology as well as biological systems. Following a concern that seems natural to archaeology, they are especially concerned with the understanding of long-term human–environment intersections.

Also in this volume, Zarankin and Salerno take up a productive discussion on Antarctica, the "wild continent," which has proved to be an important laboratory for thinking about environmental issues. In their chapter they present new thoughts on the Anthropocene in Antarctica that is based on a review of their theoretical concerns. It is worth noting the authors' intellectual trajectory, that coincides with that which many of us have done, taking into account new paradigms established by the discipline. In their discussion, they move away from an approach concerned essentially with the search for artifacts and structures capable of revealing past social practices, to an approach based on what they called a "web perspective," which is interested in other beings and materialities, and the way they relate through fluxes and experiences.

1.5 Toward a New Ethics?

From the principle established by Wheeler on the first page of his foreword in *Archeology from the Earth* (1954) that "the archaeologist is digging up, not things, but people" to idealistic approaches, focused on the recovery of meaning (Hodder 1984; Leone 1982), archaeology has been reiteratedly anthropocentric. Although the relationships between people and the environment are sometimes considered, our interest has been largely directed toward human cultures (e.g., Binford 1972, pp. 105–113; Clark 1960). Obviously, archaeology's preoccupation with human cultures is absolutely legitimate and indispensable. But what if we include among our concerns an inclusive and symmetrical perspective that takes into account other beings, other entities? Would we not be in a position to offer new ways of understanding human societies, to engage with people and the world more fully and finally to engage more effectively with the environmental problems of our time?

One issue that demands our consideration is the inexorable fact that we are witnessing large-scale environmental transformations, many of which irreversible, and which are moving toward a disturbing unplanned future (Sardar and Sweeney 2015); and as scholars we need to address this problem within our field of knowledge (Mrozowski, this volume). Since the publication of *Silent Spring* (Carson 1962), considered a landmark of the environmentalist movement, more than half a century has passed, without historical archaeology's presenting itself as a participant in the debates and actions related to environmental concerns. However, serious efforts in this direction have been made more recently by some scholars, perhaps indicating a major change in the course of our discussions on the subject. Moving beyond post-modern thinking, these authors have turned to a more inclusive ethics, taking into account the rights of nonhumans, and offered elements that contribute to our confrontation of environmental issues (Harrison 2015; Rockman 2012; Solli 2011). In the development of these new perspectives, the influence that the Anthropocene has exerted is evident. Although unofficial, the concept of the Anthropocene has allowed us to increase our self-awareness as well as provide a new impetus for the environmental movement, which now can engage a much more diverse number of players.

As Murray points out (this volume), when we think about the relationship of people to the environment there is a difference of conception between *living in* and *living with*. The latter implies the need for sustainable practices, a field with which archaeology has begun to show signs of becoming engaged (Carman 2016). And here are at least two important points potentially linked to the construction of a new ethics, one more theoretical and another practical. The first point is that sustainability is not a notion that only implies in the maintenance of human life, but also that of other beings; and in this sense, it calls for a break with the concept of dual ontologies (Harrison 2015, p. 33). In this case the post-humanist thinking (Sørensen 2013, p. 3) gives us new paradigms to employ when a New Materialism (Bennett 2016, pp. 69–71) or a Multispecies Archaeology (Pillar 2018, pp. 1–6) insist on decentralizing the human aspect of culture–nature relationships. The second concerns the fact that the concept of sustainability includes a vast range of economic, political, social, cultural and ecological issues, which requires archaeologists to develop abilities to establish dialogues with a variety of new fields, which actually is a quite a familiar practice for us. And in this other case, the practice of archaeology needs to be less hypothetical and more real, such as presenting the archaeological knowledge to the public (González-Ruibal 2013) or respecting the public's right to the archaeological knowledge (Gnecco and Lippert 2014)—whatever the venue is take the engagement needs to be translational (Zimmerman 2010). Historical archaeology has much to offer to this debate, given its proximity to recent climatic phenomena, both in terms of thinking and material evidence.

At the least, this volume aims to gather contributions focused on understanding the environment through the lens of historical archaeology. Pressing issues such as climate change, global warming, the Anthropocene and loss of biodiversity have pushed scholars from different areas to examine issues related to the causes, processes, and consequences of these phenomena. As traditional barriers between natural and social sciences have been torn down, these issues have gradually occupied a central place in the fields of anthropology. As archaeology involves the transdisciplinary study of cultural and natural evidence related to the past, it is in a privileged position to discuss the historical depth of some of the processes related to environment that are deeply affecting the present generations. Thus, it is the goal of this volume to bring together substantial and comprehensive contributions to the understanding of the global environment in a historical perspective.

References

Andrén, A. (1998). *Between artifacts and texts: Historical archaeology in global perspective*. New York: Springer.

Anschuetz, K. F., Wilshusen, R. H., & Scheick, C. L. (2001). An archaeology of landscapes: Perspectives and directions. *Journal of Archaeological Research, 9*(2), 157–221.

Bennett, L. (2016). Thinking like a brick: Posthumanism and building materials. In C. A. Taylor & C. Hughes (Eds.), *Posthuman research practices in education*. London: Palgrave Macmillan.

Binford, L. R. (1972). *An archaeological perspective*. New York: Seminar Press.

Branton, N. (2009). Landscape approaches in historical archaeology: the archaeology of places. In T. Majewski & D. Gaimster (Eds.), *International handbook of historical archaeology* (pp. 51–65). New York: Springer.

Callon, M. (1986). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In J. Law (Ed.), *Power, action and belief: A new sociology of knowledge?* (pp. 196–223). London: Routledge.

Carman, J. (2016). Educating for sustainability in archaeology. *Archaeologies, 12*(2), 133–152.
Carson, R. (1962). *Silent spring*. Boston: Houghton Mifflin/Riverside Press.
de Castro, E. V. (1996). Os pronomes cosmológicos e o perspectivismo ameríndio. *Mana, 2*(2), 115–144.
Chakrabarty, D. (2009). The climate of history: Four theses. *Critical Inquiry, 35*, 197–222.
Clark, G. (1960). *Archaeology and society* (3rd ed.). London: Methuen.
Costa, D. (2011). Archaeo-environmental study of the Almas river: Mining pollution and the Cerrado biome in the end of the nineteenth century in Mid-Western, Brazil. *Journal of Archaeological Science, 38*, 3497–3504.
Costa, D. (2018). From an environmental historical archaeology to an historical Ecoarchaeology. In C. E. Orser Jr., P. P. Funari, S. Lawrence, J. Symonds, & A. Zarankin (Eds.), Handbook of global historical archaeology. London: Routledge.
Crutzen, P. J., & Stoermer, E. F. (2000). The Anthropocene. *Global Change Newsletter, 41*, 17–18.
Deagan, K. (2008). Environmental archaeology and historical archaeology. In E. J. Reitz, C. Margaret Scarry, & S. J. Scudder (Eds.), *Case studies in environmental archaeology* (pp. 21–42). New York: Springer.
Deetz, J. (1977). *In small things forgotten: The archaeology of early American life*. Garden City: Anchor Press/Doubleday.
Deetz, J. (1990). Prologue: Landscapes as cultural statements. In W. M. Kelso & R. Most (Eds.), *Earth patterns: Essays in landscape archaeology* (pp. 1–6). Charlottesville: University Press of Virginia.
Descola, P. (1992). Societies of nature and the nature of society. In A. Kuper (Ed.), *Conceptualizing society* (pp. 107–126). London: Routledge.
Edgeworth, M. (2011). *Fluid pasts*. London: Bristol Classical Press.
Edgeworth, M. (2014a). Archaeology of the Anthropocene. *Journal of Contemporary Archaeology, 1*(1), 3–132.
Edgeworth, M. (2014b). On the agency of rivers. *Archaeological Dialogues, 21*(2), 15–159.
Gnecco, C., & Lippert, D. (2014). *Ethics and archaeological praxis*. New York: Springer.
González-Ruibal, A. (2007). Arqueología Simétrica: un giro teórico sin revolución paradigmática. *Complutum, 18*, 283–319.
González-Ruibal, A. (2012). Hacia otra arqueología: diez propuestas. *Complutum, 23*(2), 103–116.
González-Ruibal, A. (2013). *Reclaiming archaeology: Beyond the tropes of modernity*. London: Taylor & Francis.
Gosden, C. (2005). What do objects want? *Journal of Archaeological Method and Theory, 12*(3), 193–211.
Hall, M. (1999). Subaltern voices? Finding the spaces between things and words. In *Historical archaeology: Back from the edge* (pp. 193–203). London: Routledge.
Hamilton, C. (2015). Getting the Anthropocene so wrong. *The Anthropocece Review, 2*(2), 1–6.
Haraway, D. (2015). Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin. *Environmental Humanities, 6*, 159–165.
Hardesty, D. L. (1999). Historical archaeology in the next millenium: A forum. *Historical Archaeology, 33*(2), 51–58.
Hardesty, D. L. (2001). Issues in preserving toxic wastes as heritage sites. *The Public Historian, 23*(2), 19–28.
Hardesty, D. L. (2010). *Mining archaeology in the American West*. Lincoln: University of Nebraska Press.
Harrison, R. (2015). Beyond "natural" and "cultural" heritage: Toward an ontological politics of heritage in the age of anthropocene. *Heritage and Society, 8*(1), 24–42.
Hodder, I. (1984). Archaeology in 1984. *Antiquity, 58*(222), 25–32.
Hodder, I. (2012). *Entangled: An archaeology of the relationships between humans and things*. Malden: Wiley-Blackwell.
Hodder, I. (2016). *Studies in human-thing entanglement*. Ian Hodder. https://www.worldcat.org/title/studies-in-human-thing-entanglement/oclc/959419038&referer=brief_results

Ingold, T. (2000). *The perception of the environment: essays on livelihood, dwelling & skill*. New York: Routledge.
Ingold, T. (2011). *Being alive: Essays on movement, knowledge and description*. London/New York: Routledge.
Johnson, M. (2007). *Ideas of landscape*. Malden/Oxford: Blackwell.
Jones, O., & Cloke, P. (2008). Non-human agencies: Trees in place and time. In C. Knappett & L. Malafouris (Eds.), *Material agency* (pp. 79–96). Berlin: Springer.
Kehoe, A. B. (2013). Prehistory's history. In P. Schmidt & S. A. Mrozowski (Eds.), *The death of prehistory* (pp. 31–46). Oxford: Oxford University Press.
Kelso, W. M., & Most, R. (1990). *Earth patterns: Essays in landscape archaeology*. Charlottesville: University Press of Virginia.
Knapp, A. B., & Ashmore, W. (1998). Archaeological landscapes: Constructed, conceptualized, ideational. In W. Ashmore & A. Bernard Knapp (Eds.), *Archaeologies of landscape. Contemporary perspectives* (pp. 1–30). Oxford: Blackwell.
Knappett, C. (2004). The affordances of things: A post-Gibsonian perspective on the relationality of mind and matter. In E. DeMarrais, C. Gosden, & C. Renfrew (Eds.), *Rethinking materiality: The engagement of mind with the material world* (pp. 43–51). Cambridge: McDonald Institute Monographs.
Knappett, C., & Malafouris, L. (2008). *Material agency: Towards a non-anthropocentric approach*. Berlin: Springer.
Kristiansen, K. (2014). Towards a nes paradigm? The third science revolution and its possible consequences in archaeology. *Current Swedish Archaeology, 22*, 11–71.
Lane, P. (2013). Presencing the past: Implications for bridging the history/prehistory divide. In P. Schmidt & S. A. Mrozowski (Eds.), *The death of prehistory* (pp. 47–68). Oxford: Oxford University Press.
Latour, B. (2005). *Reassembling the social*. Oxford: Oxford University Press.
Latour, B. (2017). *Facing Gaia*. Cambridge: Polity.
Law, J., & Hassard, J. (1999). *Actor network theory and after*. Oxford/Malden: Blackwell.
Leone, M. P. (1982). Some opinions about recovering mind. *American Antiquity, 47*, 742–760.
Leone, M. P. (1984). Interpreting ideology in historical archaeology: Using rules of perspective in the William Paca Garden in Annapolis, Maryland. In D. Miller & C. Tilley (Eds.), *Ideology, power and prehistory* (pp. 25–35). Cambridge: Cambridge University Press.
Leone, M. P. (1989). Issues in historical landscapes and gardens. *Historical Archaeology, 23*(1), 45–47.
Lewis, S. L., & Maslin, M. A. (2015). Defining the anthropocene. *Nature, 519*, 171–180.
Liebmann, M., Farella, J., Roos, C. I., Stack, A., Martinia, S., & Swetnamb, T. W. (2016). Native American depopulation, reforestation, and fire regimes in the Southwest United States, 1492–1900 CE. *PNAS, 113*(6), 1–9.
Little, B. J. (1992). Text-aided archaeology. In B. Little (Ed.), *Text-aided archaeology*. Boca Raton: CRC Press.
Lovelock, J. (1979). *Gaia: A new look at life on earth*. Oxford/New York: Oxford University Press.
Lucas, G. (2005). *The archaeology of time*. London/New York: Routledge.
Matthews, C. N. (2007). History to prehistory: An archaeology of being Indian. *Archaeologies, 3*(3), 271–295.
Mitchell, M. D., & Scheiber, L. L. (2010). Crossing divides: Archaeology as long-term history. In L. L. Scheiber & M. D. Mitchell (Eds.), *Across a great divide: Continuity and change in native north americam societies (1400–1900)* (pp. 1–22). Tucson: The University of Arizona Press.
Morton, T. (2016). *Dark ecology: For a logic of future coexistence*. New York: Columbia University Press.
Mrozowski, S. A. (2006). Environments of history: Biological dimensions of historical archaeology. In M. Hall & S. W. Silliman (Eds.), *Historical archaeology* (pp. 23–41). Malden: Blackwell.
Mrozowski, S. A., Bell, E. L., Beaudry, M. C., Landon, D. B., & Kelso, G. K. (1989). Living on the Boott: Health and well being in a boardinghouse population. *World Archaeology, 21*(2), 299–319.

Olsen, B. (2003). Material culture after text: Re-membering things. *Norwegian Archaeological Review, 36*(2), 87–104.
Olsen, B. (2010). *In defense of things: Archaeology and the ontology of objects*. Archaeology in society series. Lanham: AltaMira Press.
Overton, N. J., & Hamilakis, Y. (2013). A manifesto for a social zooarchaeology. Swans and other beings in the Mesolithic. *Archaeological dialogues, 20*(2), 111–136.
Pellow, D. N. (2000). Environmental inequality formation: Toward a theory of environmental injustice. *American Behavioral Scientist, 43*(4), 581–601.
Pilaar Birch, S. E. (2018). Introduction. In S. E. Pilaar Birch (Ed.), *Multispecies archaeology*. London: Routledge.
Preucel, R. W. (2012). Archaeology and the limitations of actor network theory. Paper presented at the Department of Anthropology, Harvard University, Cambridge, Mass, Oct 10, 2012.
Preucel, R. W. (2016). Pragmatic archaeology and semiotic mediation. *Semiotic Review, 4*, 1–8.
Rockman, M. (2012). The necessary roles of archaeology in climate change mitigation and adaptation. In M. Rockman & J. Flatman (Eds.), *Archaeology in society: Its relevance in the modern world* (pp. 193–215). New York: Springer.
Rubertone, P. (1986). Historical landscapes: Archaeology of place and space. *Man in the Northeast, 31*, 123–138.
Rubertone, P. (1989). Landscape as artifacts. Comments on the archaeological use of landscape treatment in social, economic e ideological analysis. *Historical Archaeology, 23*(1), 50–54.
Sardar, Z., & Sweeney, J. A. (2015). The three tomorrows of postnormal times. *Futures, 5*, 1–13.
Shackel, P. A., & Palus, M. (2006). Remembering an industrial landscape. *International Journal of Historical Archaeology, 10*(1), 49–71.
Shanks, M. (2007). Symmetrical archaeology. *World Archaeology, 39*(4), 589–596.
Smith, B. D., & Zeder, M. A. (2013). The onset of the Anthropocene. *Anthropocene, 4*, 8–13.
Solli, B. (2011). Some reflections on heritage and archaeology in the anthropocene. *Norwegian Archaeological Review, 44*(1), 40–54.
Sørensen, T. F. (2013). We have never been Latourian: Archaeological ethics and the Posthuman condition. *Norwegian Archaeological Review, 46*(1), 1–18.
Tilley, C., Hamilton, S., Harrison, S., & Anderson, E. (2000). Nature, culture, clitter: Distinguishing between cultural and geomorphological landscapes; the case of hilltop tors in South-West England. *Journal of Material Culture, 5*(2), 19–224.
Ucko, P. J., & Layton, R. (1999). *The archaeology and anthropology of landscape : Shaping your landscape*, *One world archaeology*. London/New York: Routledge.
Van der Veen, M. (2014). The materiality of plants: Plant–people entanglements. *World Archaeology, 45*(5), 799–812.
Webmoor, T. (2007). Un giro más tras el “giro social”. El principio de la simetría en arqueología. *Complutum, 18*, 296–304.
Webmoor, T., & Witmore, C. L. (2008). Things are us! A commentary on human/things relations under the banner of a ‘social’ archaeology. *Norwegian Archaeological Review, 41*(1), 53–70.
Wheeler, M. (1954). *Archaeology from the earth*. Oxford: Clarendon Press.
Witmore, C. L. (2007). Symmetrical archaeology: Excerpts of a manifesto. *World Archaeology, 39*(4), 546–562.
Witmore, C. L. (2014). Archaeology and the new materialisms. *Journal of Contemporary Archaeology, 1*(2), 203–246.
Witmore, C. L. (2015). Bovine urbanism: The ecological corpulence of *Bos Urbanus*. In B. Clarke (Ed.), *Earth, life and system: Interdisciplinary essays on environment and evolution* (pp. 225–249). New York: Fordham University Press.
Zalasiewicz, J., Waters, C. N., Summerhayes, C. P., Wolfe, A. P., Barnosky, A. D., Cearreta, A., Crutzen, P., et al. (2017). The Working Group on the Anthropocene: Summary of evidence and interim recommendations. *Anthropocene, 19*, 55–60.
Zimmerman, L. J. (2010). Courtney Singleton and Jessica Welch. Activism and creating a translational archaeology of homelessness. *World Archaeology, 42*(3), 443–454.

Part I
Conceptual Frameworks

Chapter 2
More than Just a Record: Active Ecological Effects of Archaeological Strata

Matt Edgeworth

Abstract The totality of archaeological strata or humanly modified ground is taken here to comprise a global-scale stratigraphic entity called 'the archaeosphere'. Normally characterized in relatively passive and static terms as a mere record or residue of past human action, the archaeosphere is shown to be an extremely vibrant and active set of deposits. The many interactions, influences and impacts of such ground on other parts of ecological systems are briefly examined. It is concluded that though the archaeosphere was partly created, transformed and extended by humans, it is now so substantial it can be regarded as having an independent existence in its own right. Forming part of the landscape, as the very ground itself, it has become an environmental entity, shaping other things as much as it is shaped by them. As the accumulation of a multiplicity of tiny effects, added together to make a global force, the archaeosphere will continue to have powers of distributed material agency and thus the capacity to generate ecological effects far into the future, even in a post-human world.

2.1 Introduction

Wherever you are when reading this chapter, the probability is that you are situated directly above deposits of humanly modified ground, referred to here as the archaeosphere. If you are currently in a building such as a library or apartment block, the walls stand upon and are supported by a platform of such material. If you are near the centre of a city, the accumulated layers of occupation debris, rich in artefact inclusions and the remains of humans and domesticated species, may be up to many metres in depth. In the event you are travelling by plane over nonurban areas, it is probable that you are flying over landscapes extensively shaped in some way by human-related activities. Look out the window and see for yourself, bearing in mind that the surface traces observed from the air have unseen stratigraphic depth to

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them: there is more there than meets the eye. If you are flying over the sea, no such traces may be visible on the surface of the water, but deposition of anthropogenic sediments extends into many of the coastal marine regions you are likely to pass over. The mud of the sea floor around the coast contains multiple shipwrecks, material transported by ocean currents from inundated coastal landfills, dumps of ballast from ships' holds and microscopic particles of plastic and other manufactured materials/contaminants.

This chapter first provides an overview of the extent of the archaeosphere as a global-scale stratigraphic entity still very much in the process of formation. Following a brief discussion of the history of the concept, the chapter goes on to examine the many active interactions, influences and impacts of this ground on other parts of ecological systems (more a framework and agenda for future research than a comprehensive account, such is the size of the task to be tackled). This is an unusual approach because archaeological strata are conventionally apprehended on the somewhat smaller scale of the trench, site, region or landscape, not so much on a global level of analysis. Such deposits also tend to be regarded for the most part as relatively passive, subject to being shaped but not so much shaping things in their own right. In archaeology, they are taken to constitute a material record, composed of traces of past human activity, rather than a set of active material forces. The idea that it might be more than just a record—that it might react and shape the forces that leave traces upon it, or have its own extensive and lasting effects on the wider environment—is considered.

The question is asked: how could such a set of deposits be spread over large parts of the surfaces of the Earth, growing in depth and lateral extent as time proceeds, and not have substantial effects on underlying strata, geomorphological processes, physical cycles, ecosystems, habitats and climates?

2.2 The Archaeosphere: An Overview

The term 'archaeosphere' refers to a set of material phenomena characterized differently by different disciplines. Archaeology, geology, urban studies, soil science, ecology and architecture all have their own specific methods and perspectives for apprehending it. In the context of current debate about the Anthropocene—the proposed new geological epoch marked by human impact on Earth systems and geological strata (Crutzen and Stoermer 2000; Waters et al. 2016)—such overlapping disciplinary approaches need to be merged, however difficult it may be to combine them. So while this chapter draws from valuable research on archaeological strata (Carver 1987; Harris 1989), artificial ground (Ford et al. 2010; Ford et al. 2014; Price et al. 2011), urban ground (Turpin 2013), anthropogenic biomes or 'anthromes' (Ellis 2011), anthropogenic and technogenic soils (Food and Agriculture Organization for the UN 2015) and legacy sediments (James 2013), it also seeks to move beyond those categories and the differences between them—towards an understanding of humanly modified ground as a global-scale stratigraphic entity unconfined by disciplinary boundaries.

In broad interdisciplinary terms, the archaeosphere can be defined as the totality of ground significantly modified by human activities (Edgeworth 2014a, 2016a, 2017), often characterized by abundant inclusions of artefacts, manufactured materials, human burials and the remains of domesticated species. On land it is partly composed of cultivation soils, urban occupation deposits, landfills, dumps of excavated material, earthworks and so on. It contains archaeological entities such as layers, cuts, fills, lenses and dumps. But it also contains building foundations, constructed voids and other architectural structures along with infrastructure such as service pipes and cables—some still in use, some dormant and some obsolete and abandoned (Wallsten 2015). It is extended downward into earlier geological strata through the cutting of mines, quarries, metros, road tunnels, wells and other kinds of drillings, diggings and borings. The excavation and deposition of materials are inextricably connected, in the sense that what is dug up from depth gets redistributed in some form at or near the surface (Denizen 2013)—a kind of humanly wrought geological uplift. Thus the millions of tons of clay excavated during the digging of London metro tunnels were used to fill in quarries, to construct railway embankments and to form 'reclaimed' land on margins of estuaries, amongst other things (Williams et al. forthcoming). All this is now part of the growing archaeosphere layer.

This set of cuts, accumulations and deposits started forming locally in isolated places thousands of years ago and has been expanding and coalescing into larger formations ever since, with a recognizable lower boundary that distinguishes it from underlying geological strata—the diachronous Boundary A (Edgeworth et al. 2015). It is still growing—and at increasing rates—today. Partly an unintentional outcome and partly the result of deliberate design, it is created not only by human beings but also (increasingly) by machines, including pre-programmed computerized devices and robotic devices operated remotely, sometimes from considerable distances away. Tunnel-boring machines, for example, are often remotely guided and can achieve high levels of cutting precision because of their sophisticated computer systems.

Nonhuman creatures implicated in the formation of the archaeosphere include the large numbers of domesticated species under human control. The biomass of domesticated animals and birds was recently calculated as approximately four times that of humans (Smil 2011), and their impact on landscapes and strata (not to mention the habitats of wild species) is correspondingly huge. Non-sentient material entities such as the flow of water in rivers, generally treated as part of natural systems, must also be included in the assemblage of participatory forces. The extent of anthropogenic modification of rivers (Edgeworth 2011; Kelly et al. 2017) is such that patterns of erosion and deposition of sediment can be regarded as substantially influenced by human activity. The geomorphological processes involved in river sediment flux are greatly affected by agriculture, mining, forest clearance and so on (Syvitski and Kettner 2011).

One way to think of the archaeosphere is as a kind of material residue of human existence. As world population of human beings increases with corresponding rises in numbers of domesticated animals and plants, so that residue accumulates and spreads. It now covers large parts of the ice-free terrestrial surfaces of the Earth, and extends also onto lakebeds, estuaries and deltas, and substantial parts of the ocean floor. However, while it is undoubtedly a residue of sorts, it is much more than that. It has grown to be such a substantial entity, a hyperobject even (Morton 2013), that it is now a prime mover and catalyst of environmental change, with active interactions, influences and impacts on other parts of ecological systems.

In archaeology anthropogenic strata are generally understood to constitute a kind of record—the so-called archaeological record or material record (Patrik 1985; Lucas 2012), comprising multiple traces or marks of past human action. This is related to the residue idea: both records and residues are made up of substances or traces that are left behind. Archaeosphere deposits do indeed provide a very detailed record of human–environment interactions, extending from prehistoric times right up to the present day, and archaeology has developed effective methodologies for unravelling information contained within its complex stratigraphic configurations (Harris 1989, 2014). Notwithstanding its undeniable usefulness as a record, however, that is not the sum of its overall significance. It is more than a record of human action. It an ecological entity of global scale, exerting and radiating its own influences and impacts almost independently of the latest generation of people who fleetingly inhabit its changing surface and leave the most recent marks upon it.

2.3 A Brief History of the Archaeosphere Concept

The concept of the archaeosphere has a very recent origin. The term was initially coined, as far as I can ascertain, by Capelotti (2009), in the context of the emerging field of archaeology of space. It was used at first to refer to the traces and remains of human activity on the surface of the moon and other celestial bodies—for example the Apollo moon-landing sites or impact craters of spaceships on the surface of Mars. But if the term is appropriate to describe traces of human activity on the surface of the moon, as seen from orbiting spacecraft, it seems logical and appropriate to use it for that on Earth too. Thus it was that, the following year, the same author used the term to signify the remains of human activity on the surface of the Earth, as viewed from orbiting satellites using remote sensing (Capelotti 2010), though without giving a full explanation of the meaning of the term or its implications.

Work undertaken on Egyptian landscapes by Sarah Parcak showed how remote sensing and high-resolution satellite imagery was challenging conventional scales on which archaeological evidence could be apprehended. From computer analyses of infra-red photos taken from satellites 700 km above the Earth's surface, Parcak discovered 17 pyramids, 1000 tombs, >3000 mud-brick houses and large areas of the street plan of the ancient city of Tanis buried under sand (Parcak 2009; BBC 2011). It would have taken decades of survey and digging to reveal just a fraction of that evidence.

Allied with vantage points in space, then, are tremendous technological advances with regard to detection and mapping of evidence, transforming the discipline of archaeology and its forms of visualization (Edgeworth 2014b). When 9000 new sites were spotted in an area of about 23,000 square kilometres of Northern Mesopotamia (Menze and Ur 2012), it was not just human beings making the discoveries. Computer algorithms were used for the scanning of satellite images, searching for discolorations in soils that would indicate the presence of anthrosols (humanly modified soils) and associated settlement mounds known as tells. Thus the very act of discovery itself has been at least partly delegated to computers. It is through computers and associated technological apparatus, and the unprecedented scale of findings thus facilitated, that the archaeosphere as a large-scale entity has started to come into view.

The archaeosphere is not the only concept to originate from vantage points in space. The so-called Gaia hypothesis developed by James Lovelock and Lyn Margulis, which understands the Earth as a single self-regulating system (Lovelock 1979), was partly inspired by the 'Blue Marble' photo taken by Apollo 17 astronauts in 1972. Ecological thinking was radically transformed from the moment that view of our fragile but beautiful planet suspended in the blackness of space was captured on camera. The subsequent development of Earth System Science, which often uses the Blue Marble picture as a kind of unofficial symbol, was partly the outcome of that transformation of thought (National Research Council 1986). All subjects of study will probably be fundamentally altered in some way by that extraordinary photo, and the changes in perspective it brought with it. The change in archaeology has just taken longer to manifest than has been the case with some other disciplines.

Most concepts have multiple points of origin, and the archaeosphere is no exception. It should be remembered that it is more than just an idea: it has material reality to it. The archaeosphere as a material entity has been forming and growing for thousands of years. People have been living in it and on it; so they could hardly fail to notice it, at least on a local level, even if—as the ground beneath their feet—it was largely taken for granted. As it has grown, this material presence has been pressing into human experience and forcing itself into human consciousness. The question is when exactly it started to impinge into intellectual awareness. Encounters with aspects of it—apprehended at different scales and under various alternative names—can be traced back at least to the mid-nineteenth century. When the massive defensive ramparts that once encircled the city of Vienna were removed to make way for the Ringstrasse in the mid-nineteenth century, for example, the renowned Austrian geologist Eduard Suess was on hand to witness the exposure of urban archaeosphere strata, which he called the *Schuttdecke* or 'rubble blanket' (Suess 1862). His maps and drawings can now be appreciated as the first scientific representations of the urban archaeosphere (Edgeworth 2016a). Though not apprehending it on anything like a global scale, he nevertheless perceived and recorded it on the scale of a city.

The early involvement of Eduard Suess is significant. He was the first person to use the ecological term 'biosphere'—denoting one of several spherical envelopes around the Earth, with the biosphere located between the lithosphere and atmosphere, and intermeshed with both (Suess 1885). How interesting, then, that he was also one of the first to explore and map the archaeosphere, albeit knowing it by a different name. To study the archaeosphere today is to reconnect with the work of Suess. This is more than just a reference to a great name from the past: the mapping work he did can be usefully incorporated into current projects. By comparing the urban archaeosphere of Vienna as mapped by Suess in the mid-nineteenth century with the vastly expanded set of anthropogenic deposits observable there today, for example, it becomes possible to quantify its rate of growth over a period of 160 years, enabling us to visualize its development through time as the growing, spreading, shape-shifting, time-transgressive entity it really is.

Cities throughout the world have expanding urban archaeosphere deposits. For a contemporary geological account of the urban archaeosphere in a different but roughly comparable city, see the recent study of Pisa by Bini et al. (2017). But this is by no means just a European phenomenon, as demonstrated by ongoing work on mapping and characterizing the 'technogenic landforms' of Sao Paolo, Brazil (Peloggia et al. 2014; Luz and Rodrigures 2015). For an archaeological perspective, see the account of the many ships and other artefacts buried beneath later development in San Francisco's waterfront area (Delgado 2009).

Archaeologists have a long-standing interest in archaeosphere deposits, though until recently this was focused on material evidence encountered on the relatively small scales of trench, site or landscape. There are now several reasons that archaeologists are starting to grapple with archaeological evidence on something approaching a global scale. Two of these have already been mentioned: transformations in perception and discovery afforded by vantage points in space that did not exist before, and better visualization of evidence afforded by related technological advances. Other reasons are the increased focus on the archaeology of recent historical periods, with frontiers of that which is considered to be archaeological moving rapidly forward in time to include material remains of the present (Gonzalez-Ruibal 2006; Graves-Brown et al. 2013; Lucas 2015), and contact with interdisciplinary debate on the Anthropocene (Edgeworth et al. 2014), which challenges all subjects including archaeology to frame their evidence in global as well as local and regional terms. It is partly as a result of all these trends that the archaeosphere as a global-scale entity is now emerging and taking form in archaeological thought.

2.4 Intermeshing Spheres

The importance of taking the effects and influences of humanly modified ground into account is multiplied when its vertical situation is considered. It occupies that vibrant surface or near-surface region where lithosphere, hydrosphere, atmosphere and biosphere all intermesh—the Critical Zone (Richter and Billings 2015). This is where sunlight falls upon the soil and its green mantle of plants to be transmuted through photosynthesis into other kinds of energy (or gets reflected off from surfaces of concrete, tarmac, metal and glass). It is where rain seeps into the ground to be absorbed into wetlands, to percolate through soils and permeable rock, to be absorbed through roots and to find its way into rivers and streams or the living bodies of animals (or runs off rapidly from concrete or tarmac surfaces to be channelled into sewers or other artificial conduits). It is where vegetation supported by soil absorbs CO_2 from the atmosphere and releases oxygen and water vapour (or not, as the case may be, if the vegetation has been cut down). The Critical Zone is taken to extend from the top of the canopy of vegetation through the soil to the bottom of the groundwater some distance below ground level. Most terrestrial life is sustained within this fragile skin or living membrane covering the land surfaces of the planet.

Here, in this most heterogeneous and complex region of Earth, the effects and influences of humanly modified ground are so much greater than would be the case if it were (as parts of it will be in the far future) more deeply buried. The following sections explore these effects on what are generally taken as the four main intermeshing spheres of the Earth system. But to the geosphere, hydrosphere, atmosphere and biosphere should be added a fifth sphere, for the 'technosphere' (Haff 2014) is now thoroughly intermeshed with those other four, and has been for some considerable time. It needs to be fully incorporated into models of the Earth system developed by Earth System Science.

The technosphere can be taken to comprise 'complex social structures together with the physical infrastructure and technological artefacts supporting energy, information and material flows … including entities as diverse as power stations, transmission lines, roads and buildings, farms, plastics tools, airplanes, ballpoint pens and transistors' (Zalasiewicz et al. 2017). There is of course the danger of over-generalization in trying to encapsulate all diverse human activities and structures and objects within single categories like this, without acknowledging their unequal distribution throughout the world and its inhabitants. But the technosphere is a necessary concept for Earth System Science, which in taking a global perspective inevitably deals with generalizations to some extent, but in doing so tends to treat natural systems as if they can be separated from the human world. As a sphere of global extent, the technosphere overlaps and intermeshes with all the other spheres: for example, humans and their domesticated animals and plants belong to the technosphere and the biosphere, while fumes from diesel engines pertain to the technosphere and the atmosphere. Importantly, the technosphere is a political and social as well as material domain. Its workings and effects—and those of spheres which overlap and intermesh with it—cannot be explained entirely through natural sciences alone, but need the social sciences and humanities too.

What is the relationship between the archaeosphere and the technosphere? Zalasiewicz et al. (2017) describe the archaeosphere as part of the technosphere, in the sense of being its un-recycled waste or material residue, which over time becomes buried. This is undoubtedly true, but as already suggested, there is more to the archaeosphere than this. Accumulations of occupation debris and demolition rubble to be found under urban centres, like the *Schuttdecke* mapped by Suess in Vienna, serve as an example. Such occupation debris is a material residue *of* the city, to be sure, but also forms a platform *on* which the city stands and is supported and upon which it can be further developed in the future. Everything that happens in the city in the form of economic, social and political activity—or simply in terms of movements of people and goods from one part of the city to another—is at least partly contingent upon the build-up of anthropogenic deposits beneath the buildings and streets. In other words, this material is not just waste, not just residue. It has active effects as well as being the passive recipient of the effects of other things and forces. As 'vibrant matter' (Bennett 2010), it has a kind of material agency of its own, exerting influence upon its surroundings above and below, both enabling and constraining the workings of the functioning technosphere.

This may not be apparent at any given moment in time because the archaeosphere has the appearance of being largely static and inert on human timescales. True, the incredible vibrancy of its surface layers is sometimes apparent in the process of deposition and recycling—for example, where landfill communities sort through materials on dumping grounds such as the Boragaon landfill site in Guwahati, India, or the Koshe dump in Addis Adaba, Ethiopia (England 2017). But once settled as a stratigraphic formation in the ground, its effects on other things can be difficult to discern on human timescales. Only on longer timescales of hundreds of years—as the archaeosphere grows, changes shape, coalesces, spreads—do the effects on the development of cities and other parts of the technosphere become manifest. On these longer archaeological time scales rivers can be buried and grids of streets submerged without anyone really noticing, simply because of the lengths of time over which such processes unfold. Every now and again, though, there is a collision of time scales, when long-term processes have sudden short-term effects with real consequences for people in their everyday lives. For a spectacular example of this, in the form of the gradual submergence of a Roman gateway in Lincoln, England, caused by rising ground levels over hundreds of years, bringing about a vehicle crash in the space of a few seconds, see Edgeworth (2016b).

Viewed spatially, it is clear that the technosphere and archaeosphere intermesh, grading into each other to the extent that many entities could be said to belong to both. There are numerous areas of overlap, and it is hard to draw a definitive line between them. Generally speaking, the archaeosphere is what gets left behind in the ground when the technosphere ceases to work, consisting of no-longer-functioning parts and residues which have become buried. But obviously there are buried parts of technosphere infrastructure which are still very much functioning as part of contemporary systems, such as sewer tunnels, metros, underground cables and pipes and so on. Likewise there are parts of the archaeosphere that protrude into the functioning technosphere, such as old walls or moats which, though disused, are yet to be fully buried or covered over. In rural areas, extensive parts of hills and valleys in Asia, Europe and the Andes in South America were (and in some cases are still being) 'terraformed' by construction of terraces for agricultural purposes (Wang et al. 2014). Transformation of the topography of landscapes is so great that any subsequent farming regime or irrigation or settlement scheme often has little choice but to take the surviving earthworks (formerly part of the technosphere, now mostly part of the archaeosphere) into account, working either with or around them, perhaps incorporating them into newly configured technospheres, alternatively expending much energy and resources in removing their immense physical trace.

In order to make give an adequate account of the relationship between the archaeosphere and the technosphere, then, it is necessary to add the temporal dimension to any spatial analysis. But in acknowledging the extent of intermeshing of the two spheres through time, and in highlighting ways in which one may transform or grade into the other, let us also draw a critical distinction between them. The distinction is this. The archaeosphere is basically a stratigraphic entity (or set of entities), whereas the technosphere is not. Technosphere and archaeosphere may co-exist now, but the time will almost certainly come when only the archaeosphere will remain. Thus Zalasiewicz (2008) engages in the thought experiment of imagining what the archaeosphere or 'human event stratum' might be like in 100 million years' time, when the human technosphere has long since ceased to function. Taking this long-term view, the archaeosphere can be regarded as the material legacy or stratigraphic signature of the technosphere.

As long as the technosphere endures, however, the archaeosphere supplies it with legacies of former technospheres. Mostly these take the form of layers of rubble and ruined structures or (looking at these through archaeologists' eyes) stratified sequences of archaeological layers and features, containing structures and artefacts. But amongst these are objects of extraordinary power, such as landmines and unexploded bombs, best kept away from or approached with extreme caution. There are also 'monsters'—things so hideous or dangerous that any approach would be deadly. An example is the so-called 'Elephant's Foot' in a basement area of Chernobyl. It is a solidified wrinkled mass of melted nuclear fuel mixed with concrete, sand, core sealing material, control rods and fission products which is still eating its way downwards through the concrete floor. Radiation emitted would kill a person standing next to it in a matter of minutes, and it will continue to be radioactive for up to 100,000 years. It is an extreme example of an archaeosphere object.

This aim of the rest of this chapter is to outline the materially affective aspects of archaeological strata (characterized as the archaeosphere) on the four intermeshing spheres of atmosphere, hydrosphere, geosphere and biosphere, focusing not so much on its well-known attributes as record or residue but more on its interactions with and impacts on the wider environment—its active rather than its passive aspect. Given the amount of ground to be covered, this can only be a preliminary reconnaissance, attempting to establish some kind of basic framework and perhaps identifying key areas or examples which might be examined in more detail. Rather than a comprehensive account, it is intended more as a cursory review of research already done which might prove relevant, and a rough prospectus or manifesto for research yet to be conducted.

2.5 Interactions with the Atmosphere

Connections between archaeological strata and climate are more direct than might be supposed. Soils generally represent a globally significant carbon pool, affecting how much carbon dioxide is in the atmosphere. Since carbon dioxide is a greenhouse gas, the storage of organic carbon in soil has major implications for climate change (Kaplan et al. 2011). But the amount of carbon retained in the soil depends on how it has been used in the past by humans. Thus cultivation soils which have been regularly tilled are usually carbon-depleted, having sustained massive losses of carbon to the atmosphere through oxidization (Reicosky 2005). These are much more subject to erosion by wind and water and other geomorphological forces as a result. By way of contrast, large amounts of organic carbon are stored in heavily composted soils such as plaggens and dark earths. Deposits of *terra preta* found in parts of the Amazonian river basin are exceptionally rich in this respect (Neves et al. 2004; Roosevelt 2013).

Perhaps surprisingly, city soils such as the *Schuttdecke* recorded by Eduard Suess beneath Vienna, discussed earlier, also represent major carbon sinks, sealed beneath impervious surfaces of tarmac, concrete and stone (Edmondson et al. 2012). Partly this is due to past deposits of organic carbon in the form of soot, fire-ash, garden compost and other anthropogenically introduced material. Another factor is that the turning over of earth entailed by tillage does not happen where land is occupied by houses, shops and streets, thereby forestalling the carbon loss from soil to atmosphere that would otherwise have taken place.

As archaeosphere deposits are created or transformed, then, there are exchanges of greenhouse gases between soils and atmosphere, facilitated in part by soil oxidizing bacteria during ploughing. When left undisturbed, carbon is ‘locked in’, with implications for atmospheric levels in the present and the future. It is worth noting here that the considerable effects of anthropogenic soils on carbon dioxide levels in the atmosphere are not reducible to effects of human actions alone. Assemblages of many different kinds of entities are involved—machines such as tractors, animals such as oxen, soil bacteria and so on, as well as humans.

The most obvious example of gaseous interchange between archaeosphere and atmosphere can be observed at modern landfill sites, the fills and inclusions of which, following the pioneering work of Rathje on US landfills, can be treated as archaeological stratigraphic entities (Rathje 1992). Methane and other greenhouse gases are produced by bacteria deep within decomposing landfill material and released through pipe vents, or burnt off and used to generate electricity at small on-site power stations. Spontaneous combustion occasionally occurs deep inside landfill deposits, as the result of chemical reactions, leading to landfill fires.

The contribution of the urban technosphere to air pollution is well known, but that of the urban archaeosphere is less obvious. Gas is being piped through the urban archaeosphere all the time, and some of this is released through the soil into the atmosphere via leaks. It is when it collects and gets trapped underground that it starts to cause problems. Here anthropogenic ground configurations play a significant role, for gas may collect in artificially created voids such as tunnels and service ducts, or get trapped by soil compacted through the sheer weight of archaeosphere formations above. In Rio de Janiero, ageing infrastructure is a major contributing factor, exacerbated by soil compression and subsidence. Pipes and cables decay and cease to function properly, as technosphere entities make the gradual transition into archaeosphere entities. Leaking gas pipes combine with frayed and sparking electric cables running through the same service trenches, producing explosions which have launched heavy cast-iron manhole covers into the air and engulfed passers-by in fireballs (Romero and Barnes 2013). The archaeosphere can be quite a volatile place.

It is tempting to take the ground surface as the bounding surface between the archaeosphere and the atmosphere, but that would be a simplification, made for analytical convenience. The atmosphere runs through the archaeosphere, providing oxygen for soil microbacteria, millipedes, moles and metro users alike. The archaeosphere likewise extends into the atmosphere, sending up its clouds of dust from over-cultivated and wind-eroded soils. This intermeshing of spheres goes for the hydrosphere, geosphere and hydrosphere too, none of which can be taken to be entirely separate from the archaeosphere or from each other.

2.6 Interactions with the Hydrosphere

Anyone who has worked on the archaeology of river cities knows from experience just how inter-bedded archaeological strata and formations of humanly modified ground are with rivers themselves (Edgeworth 2011), affecting their flow in fundamental ways (Kelly et al. 2017). In Sao Paulo, Brazil, the River Pinheiros has been utterly transformed from a meandering river system with floodplain to an artificial canal, its flow reversed to feed the reservoirs of a hydroelectric power plant. In removing the meanders, 45% of the length of the river within the city has been lost. It has been doubled in width, and considerably deepened. Its flow is now almost entirely controlled by engineering structures. This transformation of the river is inextricably connected with formation of archaeosphere layers over the last 100 years, as the city has grown rapidly into the largest urban centre in the southern hemisphere. What used to be the floodplain has been covered over with blanket layers of landfill and other anthropogenic ground averaging 2 m or more in thickness. These layers provide the platform on which the modern city of tower blocks, skyscrapers, housing developments, bridges, tunnels, highways and slums has been laid out (Peloggia et al. 2014; Peloggia et al. 2017; Luz and Rodrigues 2015).

The river in Sao Paulo is integrated into an urban environment where the extent of anthropic influence is obvious. But recent research on smaller rivers in the United States has shown that even supposedly ‘natural’ streams have a hidden archaeology and cultural history to them, in the form of buried dams and large amounts of trapped sediment accumulated behind them, forming the floodplains through which the rivers now flow. The dams in question are relatively small-scale, built in the eighteenth and nineteenth centuries to provide waterpower to drive mill machinery. These had fallen into disuse and been submerged by accumulating sediment, but their influence on river morphology has been profound. Though buried, they continue to exert effects on river flow and floodplain formation (Walter and Merritts 2008).

Large dams built on major rivers for generation of hydroelectric power and water supply for irrigation or industrial use have altered regimes of river flow almost beyond recognition. Their effects on water distribution and sediment movements are massive, to the extent that heavily dammed rivers such as the Colorado, Yangtse or Nile can no longer be regarded as natural entities. They have changed state into something else entirely, neither artificial nor natural but rather some new hybrid state in between—'organic machines' as the environmental historian Richard White (1995) puts it—to become part of the material infrastructure of the technosphere.

A question which this chapter poses is, what will happen to heavily engineered rivers when human maintenance ceases? My guess is that archaeosphere entities and river forces will continue to interact with each other for an indefinite period, even if there is no human presence as such. For modern rivers there can be no return to their former natural or pristine condition, for they are too intermeshed with strata and structures of the archaeosphere ever to flow completely independently of them.

There are many examples of abandoned dams and their reservoirs, especially in Africa, Latin America and Asia. While dams may be regarded as part of the functioning technosphere when operational, they quickly become incorporated into the archaeosphere on abandonment. Most dams are giant sediment traps, and a typical scenario is for the river sediment that would normally be deposited on floodplains or deltas downstream to get trapped in the reservoir upstream of the dam, eventually blocking it up and forcing its closure. Brazil, for example, has more than 600 abandoned hydroelectric power stations, many of them choked with accumulated sediment.

Sometimes the weight of trapped sediment helps to breach the dam. In November 2015, the breaching of an iron ore tailings dam in Minas Gerais State caused the release of an estimated 60 million cubic metres of contaminated mud, killing 17, engulfing villages and displacing thousands of people. The so-called 'Mariana Disaster' resulted in a wave of mud extending over a distance of more than 200 km before reaching the ocean 15 days later. It left a blanket deposit of polluted sediment, which itself becomes part of the archaeosphere, over an area of at least 80 km^2 (Fernandes et al. 2016).

However, sediment accumulations behind dams generally contain large amounts of organic carbon, and are sometimes claimed to represent a major form of carbon sink, helping to decrease carbon dioxide levels in the atmosphere, and having some limiting effect on climate change (Li et al. 2015). Others point to the activity of microbacteria feeding on organic materials in the mud, sending large amounts of methane bubbling up through the water into the air, contributing to global warming (Maeck et al. 2013). Either way, effects of archaeosphere deposits on the hydrosphere are often associated with effects on the atmosphere too.

Some archaeosphere deposits are highly susceptible to erosion, transport and redeposition by water. This applies especially to soils which have been over-ploughed and over-cultivated, increasing the sediment loads of rivers (Syvitski and Kettner 2011). Soil erosion in such cases might be described as the indirect and unintended legacy of human actions, as well as of the action of geomorphological forces. So-called ‘legacy sediments’ (James 2013) constitute a large proportion of the materials transported by rivers which get trapped behind dams. The concept of legacy sediment is a powerful one. It contains within it the notion that humanly modified stratigraphic materials can continue to act and be acted upon, in a series of knock-on effects, long after the original human activity made it susceptible to erosion and transportation.

Landfills in lowland areas are particularly vulnerable to inundation by floods (Spencer and O’Shea 2014) and violent catastrophic events such as tsunamis, liquefying the soil matrix and redistributing the lighter and more mobile materials contained within. A significant proportion of the plastic rubbish forming the ‘Pacific Gyre’ (and similar gyres in other oceans) originated from inundated landfills. Formerly buried, it has been gouged out of its buried state by water action and transported on ocean currents, leaving heavier materials behind. With climate change likely to give rise to higher sea levels, landfills eroded by water will inevitably provide a ready source of further plastic pollution in the future.

Unconsolidated landfill and other materials destined for the ground are moved around on the surface of the oceans not just by geomorphological forces but also by ships, often taking the material from richer countries to poorer parts of the world. Stratigraphic formation processes mingle here with political currents and economic patterns of trade. From ancient times, millions of tonnes of sand, gravel or rock ballast have been loaded onto ships, taken on voyages, then dumped in and around harbours and ports considerable distances away (Burström 2017), creating marine versions of the archaeosphere. The ecological effects of this movement of materials will be briefly explored later in the section on interactions with the biosphere.

2.7 Interactions with the Underlying Geosphere

In a recent paper on scale and diversity of the physical technosphere, members of the Anthropocene Working Group (including the author) raised the question, how much do cities weigh? (Zalasiewicz et al. 2017). The question is interesting because we do not usually consider the weight of towns and cities and the downward pressure they may place on underlying strata. The very idea that cities might have a measurable weight is surprising somehow. To answer the question, it is necessary to take into account the weight of buried archaeological strata—the platform of humanly modified ground on which the city stands and is supported—as well as the weight of buildings and infrastructure above. Now is neither the time nor the place to make the necessary calculations. The question is revisited here only to remind us that archaeosphere deposits exert influence downwards as well as upwards, and to prompt us to consider other ways in which deep geological strata might be impacted upon or interacted with.

The weight of cities can combine with other factors such as excessive pumping out of groundwater to cause major subsidence. Shanghai in China is sinking at rates of 38 mm per year on average, but up to 68 mm a year in the heaviest financial district, where the tallest buildings such as the Shanghai Tower are located. The taller the building, the greater the raft of humanly modified ground needed to support it, the greater the weight which presses down, the more subsidence which has to be counteracted with yet more platform material (Springer 2012). It is something of a catch 22. The uneven subsidence across the city is deforming its subway system. It does not help that Shanghai is located in the soft muds of the Yangtze River delta.

The weight of water impounded in reservoirs behind giant dams is now widely accepted by geologists to cause earthquakes, an effect known about since publication of an influential study of earthquakes in the region of the Hoover or Boulder Dam on the Colorado River in the 1940s (Carder 1945). It is not just the weight of water, but also the weight of sediment trapped by the dam, accumulating against it and on the floor of the reservoir on its upstream side, that is relevant. In other words, this is a matter which concerns the archaeosphere as well as the technosphere, geosphere and hydrosphere.

The immediate area around the Koyna Dam and its reservoir in Western India has suffered more than 10 earthquakes of magnitude 5 or more, over 150 earthquakes of magnitude 4 and thousands of earthquakes of lesser intensity since the dam was constructed in the 1950s. The worst was in 1967, when a magnitude 6.3 earthquake claimed 200 human lives, made thousands homeless and damaged buildings and infrastructure. The pattern of earthquakes closely follows seasonal fluctuations of water levels in the reservoir. Epicentres occurred over a widespread area soon after infilling, but the area of seismic activity shrank to a much smaller and more localized zone when levels were reduced. In 1993, a southward shift in earthquake epicentres was recorded, corresponding to the construction of another giant dam and the filling of its reservoir nearby (Gupta 2002).

There are other effects of archaeosphere layers on geological strata which could be discussed here. For example, the 'armouring' of parts of the Earth's surface with concrete or tarmac or other hard impermeable surfaces influences the extent to which groundwater can penetrate to layers below, and siphons it away as run-off into sewer systems and rivers instead. The compaction of cultivation layers by heavy agricultural machinery may have similar effects. The movement of water and pollutants through the ground is greatly affected by the configuration of humanly created soil boundaries and other surfaces within it (Nirei et al. 2012). Mining or other tunnelling activities may create subsidence in geosphere layers above, which have effectively been undermined. However, there is only space in this section for these brief mentions of just a few of the processes at work, with no comprehensive or detailed coverage possible.

It is important to bear in mind that much of the archaeosphere is derived from material which has been excavated from underlying strata. It has not just materialized from nowhere. Humans, helped by their animals and machines, have brought mineral to the surface, transporting and transforming it in various ways, to redeposit it some distance from its places of origin. This leaves voids in the ground in the form of quarries, mines, tunnels and numerous other subterranean features, some of which get filled in with material transported from elsewhere, leaving further voids. Accumulation of material in one place is counterbalanced to a certain extent by the denudation of it in others. Notwithstanding the many significant effects of the archaeosphere discussed in this chapter, the very existence of the archaeosphere already implies substantial impact on underlying strata of the geosphere, even before these additional effects are considered.

2.8 Interactions with the Biosphere

Effects of humanly modified ground on other species cannot be underestimated. The spreading of archaeosphere layers across large parts of the terrestrial surfaces of the Earth inevitably involves the smothering and destruction of some habitats, and the creation and sustenance of others. Creatures like rats typically have adapted well to the conditions of the urban archaeosphere, for example (Johnson and Munshi-South 2017). On the other hand the rapid expansion and blanket-like spread of the archaeosphere is probably a contributing factor in increasing levels of wild animal extinctions. The agricultural archaeosphere favours domesticated animals such as cattle, pigs and sheep, which play a major role alongside humans in shaping and constituting its layers and landforms. It might be argued that humans also tend to flourish in the material conditions created by the archaeosphere, though this obviously does not apply equally to all. Refugees and others who have been dispossessed of land cannot use its resources in the same way as landowners can. The hundreds of millions of people inhabiting slums on the peripheries of cities throughout the world are active producers of the archaeosphere, interacting with it in multiple ways as it spreads rapidly outwards in blanket-like formations from urban centres, and sometimes deriving their livelihoods directly from it. But whether they can be called beneficiaries of it is unclear. Several million people worldwide live and work in municipal tips, such as the infamous Koshe dump in Ethiopia, where dozens were killed and 50 homes were destroyed as the result of a recent landslide, and where life expectancy is only 35 (England 2017).

Such is its radiating power that the archaeosphere also extends its influence far beyond its own geographical boundaries, effecting other habitats at a distance. Leachate from landfills leaks into groundwater, contaminating sources of drinking water, and not just for humans. Polluted storm-water run-off from urban surfaces is channelled through the archaeosphere via sewers and culverts into rivers, picking up contaminants and redepositing these in the muds of deltas and estuaries, entering the food chain of sea creatures. Dams long since abandoned exert influence on sediment flow and floodplain formation in upstream and downstream directions, transforming riverine environments and radically changing the kinds of animals and plants that can live there. Toxic chemicals from dumps of industrial waste seep into wetlands. Poisons from deserted factories escape into the air, often proving hazardous to many forms of life. Highly mobile plastic inclusions from inundated landfills are carried halfway around the world on ocean currents, to find new zones of deposition in the bodies of fish and birds as well as on the seabed. Harmful radioactivity emanates from sea-bed dumps of nuclear waste, and from ruined nuclear reactor cores at Chernobyl and Fukoshima (though paradoxically this may be beneficial to some species, in providing human-free exclusion zones where wildlife can flourish undisturbed).

All these effects are well-documented in the scientific literature, but normally considered as direct outcomes of human action. The intermediary and sometimes independent role of the archaeosphere is rarely taken into account. When it is considered, the archaeosphere itself tends to be framed as 'man-made ground' or 'artificial ground', to the exclusion of other species and material agencies involved in its creation. But the archaeosphere is not a wholly artificial entity. It forms as the outcome of a mixture of disparate forces—some human, some non-human, some artificial, some natural, some hybrid tangles of all of these. Earthworms and plant roots play a significant part in its formation and transformation, alongside humans and machines, not to mention insects and microbacteria and other neglected denizens of the soil. Processes going on in landfill layers, for example, are as much about bacteria as they are about humans, or rather the interactions between them. So it is not so much a case of explicating archaeosphere impacts *on* the biosphere, then, as if these two realms were somehow separate to begin with—more a case of showing the extent of intermeshing and entanglement.

In writing this chapter I have become aware of how easily one falls into the practice of framing the archaeosphere in terms of destruction of supposedly natural environments, the desecration of pristine landscapes, or as enemy of the non-human biosphere. But in many cases the archaeosphere *is* the environment. It *is* the landscape. There are no such things as pristine landscapes or seascapes anymore, or hard and fast divisions between human and non-human. New forms of narrative are needed to acknowledge this, yet the chapter has been trapped to some extent within the old ways of thinking. It must be admitted that negative effects of archaeological strata have been prioritized over positive ones, simply because it is easier to demonstrate efficacy through harm. But there are many positive effects which have gone largely unmentioned. Landforms created by humans in conjunction with natural forces can be exceptionally beautiful, vibrant, fertile and full of life. Not all parts of the archaeosphere are toxic to other species. Examples could be given of more productive partnerships between humans and other co-producers of the archaeosphere, especially in the important task of decomposition and recycling of organic waste.

Cultivation soils in particular are testament to the ways in which humans and plants and other agents collaborate in making use of water and sunlight and facilitating the process of photosynthesis (Richter 2007), though often today in the context of exploitative and unsustainable modes of food production. The rich and fertile *terra preta* soils from Amazonia already mentioned, derived from middens of indigenous peoples who once had gardens where forests grow now, remind us that wonderful and extraordinary things, as well as monstrosities, can be left behind as physical traces in the stratigraphic record, and some of these can be of use rather than harm to future generations.

Many of the examples given in this chapter concern the movement of materials of materials from one place to another. But to move parts of the archaeosphere around is to move its biological inhabitants with it. This has been noted for example in the case of ballast transported in ships and dumped in coastal areas (Burström 2017). In a landmark study by the Swedish entomologist Carl Lindroth (1957), 19 species of ground beetle found close to harbours (but nowhere else) in Newfoundland were shown to have been transported in ballast from places near the coast in Europe, where those species are native. Work revealed that the distribution of beetles coincided fairly precisely with the harbours that European fishing fleets used. Through historical research Lindroth discovered that large amounts of solid ballast were being shipped across the Atlantic. At first it got dumped in coastal water at entrances to harbours, but in the early seventeenth century shipping channels started to get blocked by the sheer quantity of dumped material, and regulations were introduced requiring ballast to be taken ashore. Lindroth was able to use the beetles to trace the provenance of the ballast to specific coastal regions of Western Europe (Lindroth 1957, cited in Burström 2017).

Lindroth's research is exemplary for the way it combines archaeological, historical, faunal, botanical and geographical lines of enquiry to reach a holistic understanding of specific archaeosphere deposits, which might otherwise be dismissed as just dumps of rubble. It illustrates the intermeshing of the archaeosphere and the biosphere. A comparable study using different methods was entitled *Seeds of Change* and was carried out by the Brazilian artist Maria Theresa Alves (Alves undated). Inspired by a botanical report on 135 species of so-called 'ballast plants' on the island of Reposaari off the coast of Finland, she looked at ballast plants in various European ports such as Liverpool, Marseille and Rotterdam, mapping out sites nearby where ballast had been dumped. She planted a floating ballast seed garden on an old grain barge, moored on the River Avon in Bristol. By relating the ballast plants to their places of origin, which in some cases were also the places where slaves were captured or transported to, Alves was able to explore some of the links that local families still have with those distant countries (Burström 2017).

Seeds of ballast plants can remain dormant in the ground for hundreds of years, only germinating when conditions become favourable, perhaps following a change of land use. Ballast plants thus provide a good example of the time delay that archaeosphere deposits may interpose between the original human actions that gave rise to formation of strata, and the unforeseen effects of those actions many years down the line, as happened here when the plants finally came into flower to set further seeds of their own. This is not human agency on its own, but human agency mediated and transformed through a combination of stratigraphic and biological processes and the workings of time, activated in this case by the warmth of the sun.

2.9 Conclusion

An individual archaeological stratum (in the form of a layer, lens, spread, dump or fill) probably only has significant effects on layers immediately above and below or to the side, while being influenced in turn by deposits adjacent to or contiguous with it. But the archaeosphere is all about the accumulation and coalescence of smaller stratigraphic entities into larger ones. It is a multi-scalar set of phenomena which generates effects and influences on different scales. When the total conglomeration of all such entities is added together, the multiplicity of tiny effects interacting together becomes a global force, impacting in substantial ways on wider environments, geophysical cycles and Earth systems. That is the force of the archaeosphere.

The archaeosphere is no longer tied completely to the human world or entirely dependent upon it. It has grown to be, to use Morton's term, a hyperobject—a vast and uncanny object of unimaginable scale, phasing in and out of human awareness, but now touching in some way almost every aspect of life on Earth. Its effects are not limited to impacts on people, but profoundly influence habitats of other species too, intersecting also with material flows such as rivers, and larger processes such as hydrological and carbon cycles. These influences would no doubt continue even in a post-human world. In other words, were humans to become extinct and the technosphere cease to function, the archaeosphere would still generate its substantial ecological effects, intermeshing and interacting with the atmosphere, hydrosphere, geosphere and biosphere for a considerable time to come. If this sounds apocalyptic, it is not meant to be. To envision a hypothetical world without humans, and to speculate on what might happen to long-lasting stratigraphic entities such as the archaeosphere within it, is a necessary part of engaging with time scales on a geological scale.

To return to the central theme, as identified in the title, the artefact-rich and often highly complex stratigraphic structure of the archaeosphere certainly provides an invaluable archaeological record of past human–environment interactions. But examples considered in this chapter have shown it to be much more than that. As it continues to grow and spread across the terrestrial and marine surfaces of Earth at increasing speed, incorporating more and more of the geosphere into its burgeoning mass, it actively shapes events and processes as well as passively recording them in the form of physical traces left behind in the ground.

It is more than just a record.

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References

Alves, M. T. (undated). Seeds of change: a floating ballast seed garden. Available online: https://www.arnolfini.org.uk/learning/projects/seeds-of-change/ballastseedgarden. Accessed 8 Feb 2018.

BBC website. (2011). Egyptian pyramids found by infra-red satellite images. http://www.bbc.co.uk/news/world-13522957. Accessed 25 Mar 2017.

Bennett, J. (2010). *Vibrant matter: A political ecology of things*. London: Duke University Press.

Bini, M., Pappalardo, M., Rossi, V., Noti, V., Amorosi, A., & Sarti, G. (2017). Deciphering the effects of human activity on urban areas through morphostratigraphic analysis: The case of Pisa, Northwest Italy. *Geoarchaeology, 33*(1), 43–51.

Burström, M. (2017). *Ballast: Laden with history*. Nordic Academic Press. Lund.

Capelotti, P. J. (2009). Surveying Fermi's paradox, mapping Dyson's sphere: Approaches to archaeological field research in space. In A. G. Darrin & B. L. O'Leary (Eds.), *Handbook of space engineering, archaeology, and heritage*. Boca Raton: CRC Press.

Capelotti, P. J. (2010). *The human archaeology of space: Lunar, planetary and interstellar relics of exploration*. Jefferson, NC: Mcfarland & Co.

Carder, D. S. (1945). Seismic investigations in the Boulder Dam area, 1940–1944, and the influence of reservoir loading on earthquake activity. *Bulletin of the Seismological Society of America, 35*, 175–192.

Carver, M. (1987). *Underneath English towns: Interpreting urban archaeology*. London: Batsford.

Crutzen, P. J., & Stoermer, E. F. (2000). The Anthropocene. *Global Change Newsletter, 41*, 17–18.

Delgado, J. P. (2009). *Gold Rush Port: The Maritime Archaeology of San Francisco's Waterfront*. Berkeley: University of California Press.

Denizen, S. (2013). Three holes in the geological present. In E. Turpin (Ed.), *Architecture in the Anthropocene: Encounters among design, deep time, science and philosophy*. Ann Arbour: Open Humanities Press.

Edgeworth, M. (2011). *Fluid pasts: Archaeology of flow*. London: Bloomsbury Academic.

Edgeworth, M. (2014a). The relationship between archaeological stratigraphy and artificial ground and its significance in the Anthropocene. In C. N. Waters et al. (Eds.), *A stratigraphical basis for the Anthropocene* (pp. 91–108). London: The Geological Society of London, Lyell Collection Special Publications 395.

Edgeworth, M. (2014b). From spadework to screenwork: New forms of archaeological discovery in digital space. In A. Carusi, A. S. Hoel, T. Webmoor, & S. Woolgar (Eds.). 2015. *Visualization in the age of computerization*. Routledge.

Edgeworth, M. (2016a). The ground beneath our feet: beyond surface appearances. In G. Mackert & P. Petritsch (Eds.), *Mensch macht Natur. Landschaft im Anthropozän*. Berlin: Walter de Gruyter.

Edgeworth, M. (2016b). Grounded objects: Archaeology and speculative realism. *Archaeological Dialogues, 23*(1), 93–113.

Edgeworth, M. (2017). Humanly modified ground. In D. A. DellaSala & M. I. Goldstein (Eds.), *The Encyclopedia of the Anthropocene* (pp. 157–161). Oxford: Elsevier.

Edgeworth, M., et al. (2014). Forum on archaeology of the Anthropocene. *Journal of Contemporary Archaeology, 1.1*, 79–132.

Edgeworth, M., Richter, D., Waters, C., Haff, P., Neal, C., & Price, S. (2015). Diachronous beginnings of the Anthropocene: The lower bounding surface of anthropogenic deposits. *Anthropocene Review, 2*, 33–58.

Edmondson, J. L., et al. (2012). Organic carbon hidden in urban ecosystems. *Scientific Reports, 2*, 963.

England, R. (2017). Living in landfill. *Independent*, 18th March. Available online at: http://www.independent.co.uk/news/long_reads/living-in-landfill-a7632996.html. Accessed 8 Feb 2018.

Ellis, E. C. (2011). Anthropogenic transformation of the terrestrial biosphere. *Philosophical Transactions of the Royal Society, A369*, 1010–1035.

Fernandes, G. W., et al. (2016). Deep into the mud: Ecological and socio-economic impacts of the dam breach in Mariana, Brazil. *Natureza & Conservação, 14*(2), 35–45.

Food and Agriculture Organization for the United Nations. (2015). World reference base for soil resources 2014, update for 2015. World Soil Resources Report 106.

Ford, J., Kessler, H., Cooper, A. H., Price S. J., & Humpage, A. J. (2010). An enhanced classification for artificial ground. British Geological Survey Open Report.

Ford, J. R., Price, S. J., Cooper, A. H., & Waters, C. N. (2014). An assessment of lithostratigraphy for anthropogenic deposits. In C. N. Waters, J. Zalasiewicz, M. Williams, M. A. Ellis, & A. Snelling (Eds.), *A stratigraphical basis for the Anthropocene* (pp. 55–89). London: Geological Society, Special Publications 395.

Gonzalez-Ruibal, A. (2006). The past is tomorrow: Towards an archaeology of the vanishing present. *Norwegian Archaeological Review, 39*(2), 110–125.

Graves-Brown, P., Harrison, R., & Piccini, A. (2013). *The Oxford handbook of the archaeology of the contemporary world*. Oxford: Oxford University Press.

Gupta, H. K. (2002). A review of recent studies of triggered earthquakes by artificial water reservoirs with special emphasis on earthquakes in Koyna, India. *Earth-Science Reviews, 58*, 279–310.

Haff, P. K. (2014). Technology as a geological phenomenon: Implications for human well-being. In C. N. Waters, J. Zalasiewicz, M. Williams, et al. (Eds.), *A stratigraphical basis for the Anthropocene* (pp. 301–330). London: Geological Society ., Special Publications 395.

Harris, E. (1989). *Principles of archaeological stratigraphy*. London/New York: Academic Press.

Harris, E. C. (2014). Archaeological stratigraphy: A paradigm for the Anthropocene. *Journal of Contemporary Archaeology, 1*(1), 105–109.

James, L. A. (2013). Legacy sediment: Definitions and processes of episodically produced anthropogenic sediment. *Anthropocene, 2*, 16–26.

Johnson, M. T. J., & Munshi-South, J. (2017). Evolution of life in urban environments. *Science, 17*, 358.

Kaplan, J., Krumhardt, K. M., Ellis, E. C., et al. (2011). Holocene carbon emissions as a result of anthropogenic land cover change. *The Holocene, 21*(5), 775–791.

Kelly, J., et al. (2017). *Rivers of the Anthropocene*. Oakland, CA: University of California Press.

Lindroth, C. (1957). *The faunal connection between Europe and North America*. Stockholm: Almqvist & Wiksell.

Li, G., Wang, X. T., Yang, Z., Mao, C., West, A. J., & Ji, J. (2015). Dam-triggered organic carbon sequestration makes the Changjiang (Yangtze) river basin (China) a significant carbon sink. *Journal of Geophysical Research: Biogeosciences, 120*, 39–53.

Lovelock, J. (1979). *Gaia: A new look at life on earth*. Oxford: Oxford University Press.

Lucas, G. (2012). *Understanding the archaeological record*. Cambridge: Cambridge University Press.

Lucas, G. (2015). Archaeology and contemporaneity. *Archaeological Dialogues, 22*(1), 1–15.

Luz, R., & Rodrigues, C. (2015). Anthropogenic changes in urbanised hydromorphological systems in a humid tropical environment: River Pinheiros, Sao Paulo, Brazil. *Zeitschrift für Geomorphologie, 59*(2), 109–135.

Maeck, A., et al. (2013). Sediment trapping by dams creates methane emission hot spots. *Environmental Science & Technology, 47*(15), 8130–8137.

Menze, B., & Ur, J. (2012). Mapping patterns of long-term settlement in Northern Mesopotamia at a large scale. *Proceedings of the National Academy of Sciences of the United States of America, 109*, 12.

Morton, T. (2013). *Hyperobjects: Philosophy and ecology after the end of the world*. Minneapolis: University of Minnesota Press.

National Research Council, USA. (1986). *Earth system science: Overview: A program for global change*. Washington DC: The National Academies Press.

Neves, E. G., Petersen, J. B., Bartone, R. N., & Heckenberger, M. J. (2004). The timing of terra preta formation in the Central Amazon: Archaeological data from three sites. In B. Glaser & W. I. Woods (Eds.), *Amazonian dark earths: Explorations in space and time*. Berlin: Springer.
Nirei, H., Furuno, K., Osamu, K., et al. (2012). Classification of man-made strata for assessment of geopollution. *Episodes, 35*, 333–336.
Parcak, S. (2009). *Satellite remote sensing for archaeology*. London: Routledge.
Patrik, L. E. (1985). Is there an archaeological record? *Advances in Archaeological Method and Theory, 8*, 27–62.
Peloggia, A. U. G., Silva, E. C. N., & Nunes, J. O. R. (2014). Technogenic landforms: Conceptual framework and application to geomorphologic mapping of artificial ground and landscapes as transformed by human geological action. *Quaternary and Environmental Geosciences, 5*(2).
Peloggia, A., Luz, R.A., Ortega, A., Edgeworth, M. (2017). The expansion of the urban geological stratum (Archaeosphere) in the east of the State of São Paulo: the relationship between history, geography, geology and archaeology in the Anthropocene (in Portuguese). *Revista Brasileira de Geografia, 62*(2), 25–52.
Price, S. J., Ford, J. R., Cooper, A. H., & Neal, C. (2011). Humans as major geological and geomorphological agents in the Anthropocene: The significance of artificial ground in Great Britain. *Philosophical Transactions of the Royal Society, 369*(1938), 1056–1084.
Rathje, W. (1992). *Rubbish! The archaeology of garbage*. New York: HarperCollins.
Reicosky, D. C. (2005). Tillage and gas exchange. In R. Lal (Ed.), *Encyclopaedia of soil science 2* (2nd ed., pp. 1773–1775). Boca Raton, FL: CRC Press.
Richter, D. B. (2007). Humanity's transformation of Earth's soil: pedology's new frontier. *Soil Science, 172*, 957–967.
Richter, D. B., & Billings, S. A. (2015). 'One physical system': Tansley's ecosystem as Earth's critical zone. *The New Phytologist, 206*, 900–912.
Romero, S., & Barnes, T. (2013, January 26). Rio's exploding manholes menace residents and highlight ageing infrastructure. *New York Times*. Available online: http://www.nytimes.com/2013/01/27/world/americas/rio-de-janeiro-grapples-with-exploding-manholes.html. Accessed 1 Feb 2018.
Roosevelt, A. C. (2013). The Amazon and the Anthropocene: 13,000 years of human influence in a tropical rainforest. *Anthropocene, 4*, 69–87.
Smil, V. (2011). Harvesting the biosphere. *Population and Development Review, 37*(4), 613–636.
Spencer, K., & O'Shea, F. T. (2014). The hidden threat of historical landfills on eroding and low-lying coasts. *ECSA Bulletin, 63*, 16–17.
Springer, K. (2012, May 21). Soaring to sinking: how building up is bringing Shanghai down, *Time*. http://science.time.com/2012/05/21/soaring-to-sinking-how-building-up-is-bringing-shanghai-down/. Accessed 1 Feb 2018.
Suess, E. (1862). *Der Boden der Stadt Wien*. Vienna: W. Braumüller.
Suess, E. (1885). *Das Antlitz der Erde* [The face of the earth]. Volume 1. Leipzig: G. Freytag.
Syvitski, J. P. M., & Kettner, A. (2011). Sediment flux and the Anthropocene. *Philosophical Transactions of the Royal Society A, 369*, 957–975.
Turpin, E. (2013). *Architecture in the Anthropocene: Encounters among design, deep time, science and philosophy*. Open Humanities Press. Ann Arbor.
Wallsten, B. (2015). *The URK world: Hibernating infrastructures and the quest for urban mining*. Linkoping: Linkoping University.
Walter, R. C., & Merritts, D. J. (2008). Natural streams and the legacy of water-powered mills. *Science, 319*(5861), 299–304.
Waters, C. N. et al. (2016). The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science 351,* 6269.
Wang, Y., Chen, L., Gao, Y., Wang, S., Lü, Y., & Fu, B. (2014). Carbon sequestration function of check-dams: A case study of the Loess Plateau in China. *Ambio, 43*(7), 926–931.
White, R. (1995). *The Organic Machine: the remaking of the Columbia River*. New York: Hill and Wang.

Williams, M., Edgeworth, M., Zalasiewicz, J., Waters, C. N., Steffen, W., et al. (forthcoming). Underground metro systems: A durable geological proxy of rapid urban population growth and energy consumption during the Anthropocene. In C. Benjamin, D. Baker, & E. Quadeacker (Eds.), *Routledge handbook of big history*. Abingdon: Routledge.

Zalasiewicz, J. (2008). *Earth after us*. Oxford: Oxford University Press.

Zalasiewicz, J., et al. (2017). Scale and diversity of the physical technosphere: A geological perspective. *Anthropocene Review, 4*(1), 9–22.

Chapter 3
The Archaeology of Climate Change: Is Unbridled Commodity Production Sustainable?

Stephen A. Mrozowski

Abstract Much of the discussion concerning climate change has understandably focused on providing proof that it is an empirically verifiable process whose trajectory has been accelerating. This chapter focuses on one of the prime drivers, commodity production, and asks whether it is sustainable. What the historical archaeology of the modern era clearly has established is the critical role that commodity production has played in the growth of an ever-expanding world economy. The impact this has had on the environment from the micro- to the macro-scale is also revealed by this archaeology. Ultimately, we may be confronted by the need to drastically curtail commodity production. Here I will explore the ramifications of such a future and what it suggests about issues such as universal employment.

In their recent summary of the impact climate change is having on the cultural heritage of the planet, Hambrecht and Rockman (2017) provide a comprehensive overview of how glacial melting and sea-level rise are threatening archaeological sites across the globe. Their focus on the global response to climate change is, as they describe, "a small first step toward knowledge sharing" (Hambrecht and Rockman 2017: 638). The threats they describe are real, as are the challenges that face the community of heritage planners and cultural resource professionals tasked with saving what remains of significant historical properties in coastal areas. The authors, and those like them who face these challenges, are to be commended and supported, yet in few if any cases are archaeologists addressing the deeper question of how or why humanity has reached this point to begin with. Archaeologists, along with climate scientists, know full well the scale of the problem that confronts the world, because a significant part of their research has focused on previous periods of sea-level change and how human populations have adapted to those changes. Yet here again the focus is on documenting previous periods of climate change and the

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impacts these shifts have had on human society, its economies and patterns of settlement and migration (e.g., Comstock and Cook 2017; Sassaman 2010, 2012). This work is to be lauded and encouraged to continue because it offers one of the few concrete examples of how previous experiences may be able to help humanity in planning for what is surely to be a dynamic, potentially devastating future. In this case, however, I want to focus on a different set of problems equally if not more important than those surrounding climate change. For it is not only the causes of climate change that we need to address, but also the uncertain future we face and challenges we can only imagine. But imagine them we must, because if we do not, we will have contributed to what could be humanity's greatest threat.

As archaeologists and other social theorists begin to better understand the close relationships that exist between humans and all living things on the earth-—what some call posthumanism (see Harris and Cipolla 2017: 152–170)—the fragility of these bonds comes more clearly into focus. The growth of posthumanist perspectives is an important intellectual development because it provides a concrete framework for overcoming the long-standing nature/culture dualism that rests at the heart of many problems that confront Earth at this moment in history. Transcending this divide has itself been a long-standing goal of archaeologists, anthropologists and other social theorists who have focused on the intersection of the biological and the social while rejecting dualist epistemologies more generally (e.g., Braidotti 2013, 2016; Butler 1993; Descola 2013; Descola and Pálsson 1996; De Souza 2014; Escobar 1999, 2008; Haraway 1991, 2003; Harris and Cipolla 2017; Mrozowski 1996, 2006a, b, 2010, 2012; Wolfe 2010). What posthumanism offers for the historical archaeologist interested in the environment is a general framework that focuses on the intersectionality of the biological and the social while posing ethical questions concerning the future of humanity. In this chapter I want to use a posthumanist approach in linking past, present and future that surrounds larger questions concerning the sustainability of global commodity production and the issue of universal income and employment. These are, I believe, the logical ends that emerge from any consideration of the larger project/praxis that is historical archaeology. If historical archaeology—and the study of the history of climate change more broadly (see Chakrabarty 2009, 2012)—is to have any real, pragmatic impact, it will have to transcend a focus that looks only at the environment and move to the more vexing questions that connect the past to potential futures and how they might look.

3.1 Posthumanism and Historical Archaeology

For starters, I need to be clear about my own concept of the notion of posthumanism because it is a term that means different things to different people. For the purposes of this chapter posthumanism can be defined as a framework that decenters a human-centered view of the world (but see Braidotti 2013; Wolfe 2010, for other deeper, more comprehensive discussions). Although I fully recognize that this is a rather simplistic view of a set of ideas that are far-reaching, for me the notion of posthumanism has its greatest currency when envisioned as a pathway for transcending dualist epistemologies that limit our understanding of the interwoven qualities of life on the planet. These pathways can take many forms and have varied impact on real-life problems, but for me, what is perhaps most paramount is a freedom to examine human history with a critical eye without having such ideas being viewed as antihuman when in fact their goal is to perpetuate the human species, albeit while creating a safer, more just world. Within the context of historical archaeology it is particularly important to explore the nexus of material culture—the primary focus of the field's research—and biological dimensions of processes such as colonialism, urbanization and industrialization that have and continue to influence the growth and future of the modern world (Mrozowski 2006a, b, 2010, 2012). Industrialization is perhaps the easiest example to draw on in making the case for the importance of a posthumanist understanding of the future. Although I will provide other examples of how historical archaeologists can broaden their interpretive horizons, my primary focus will be connecting the vast evidence of accelerated commodity production that is found virtually everywhere archaeologists look, and its causal connections to climate change. Once this is established I will then move on to discuss the challenges facing a world both imperiled, yet dependent on large-scale commodity production. I will then ask how best to conceptualize a world where commodity production and consumption are not the primary forms of work available for humans. What will all the people who make the things that others purchase do when it becomes clear that the production of those commodities cannot be sustained?

At the heart of this discussion will be two very different notions of how best to approach the future—one that views the adoption of technologies that enhance human capabilities as one path, versus an alternative path that sees the continuing adoption of technologies that replace human work as representing the greatest risk to global stability (see Braidotti 2016: 16–17). It is not that I am anti-technology, but I share the concern of many that a technologically advanced world where there is no place for human enterprise could result in global chaos. In keeping with a pragmatic philosophy that underlies much of my recent work (see Baert 2005; Mrozowski 2012; Preucel and Bauer 2001; Pruecel and Mrozowski 2010; Schmidt and Mrozowski 2013) I remain committed to an open process of intellectual inquiry. In this particular instance it will serve primarily as an intellectual bridle of sorts—allowing me to maintain a direction that seeks to steer clear of closed systems of research. One result will be to have my conclusions be posed as suggestions rather than pronouncement. The vantage point that I bring to both the questions and the ontologies I wish to explore—that of an historical archaeologist—might admittedly appear to be a circuitous route to such important questions as climate change and universal employment. Yet I would argue the opposite: that historical archaeology provides a powerful and underappreciated vantage point from which to examine a deep history of commodity production and climate change. Rather than developing this idea more deeply here, let me turn instead to some archaeological examples that demonstrate the value of looking at material culture—the things manufactured for people's use— in concert with biological data concerning the impact processes such as industrialization, but also colonialism and urbanism, have had, and will continue to have, on the physical well-being of all living things on the earth.

3.2 The Social–Biological Nexus in Historical Archaeology

For more than 30 years I have argued for the importance of balancing a concern for the material with a focus on the biological dimensions of large-scale historical processes such as colonialism, urbanization and industrialization (e.g., Mrozowski 1996, 2006a, b, 2010, 2012; Mrozowski et al. 1989; Reinhard et al. 1986). During this same period both historians and a small number of historical archaeologists have embraced a similar concern for the environment and the biological more broadly (e.g., Crosby 1986; Deagan 1996; Diamond 1998; Hardesty and Fowler 2001). These attempts to transcend/transverse the cultural/biological, material/immaterial divide have been greatly aided by the growth of political ecology as a field of study (e.g., Benton 1996; Biersack and Greenberg 2006; Escobar 1999; O'Conner 1998; Schroeder et al. 2006; Uggla 2010), the growth of historical ecology (e.g., Balée 1998, 2006; Balée and Erickson 2006; Crumley 1994, 2003), and the posthumanist approaches noted above. The resolution of what has been called the Red/Green debate in the formation of fields such as political ecology has provided a powerful tool for critically examining the impact capitalist-driven, large-scale commodity production has had on the environment (see Mrozowski 2010; Uggla 2010). One of the more noteworthy examples of how the social–biological nexus has been examined most fruitfully comes from the study of public health (see, e.g., Dew 2012; Dew et al. 2016). One of the reasons I note this is because unlike historical archaeologists who have focused primarily on the social and the cultural in their research, Western medicine has done the opposite. With so much emphasis placed on the biological factors that affect disease and health, Western medicine—which is undeniably successful in many respects—has failed to see the close relationship that exists among factors such as poverty, race, gender and class and the greater well-being of populations. As a result the health-care systems of many nations remain relatively blind to underlying inequalities that influence everything from patient experiences to more basic realities such as who gets health care and who doesn't. There are, however, a growing number of studies that examine the role social and cultural factors have on health disparities in highly industrialized countries (e.g., Dew 2012; Dew et al. 2016; Sweet et al. 2013; Underwood 2014).

In historical archaeology the study of health has proven to be a seldom examined, yet potentially productive avenue of research. Beyond some early attempts to examine the social factors influencing health (e.g., Geismar 1993; Mrozowski et al. 1989; Reinhard 1992, 1994; Reinhard et al. 1986) the issue of health has not been a central focus of historical archaeology nor archaeology more broadly (but see Kintigh et al. 2014). My own interest in the topic emerged as a part of an early collaboration with archaeoparasitologist Karl Reinhard of the University of Nebraska when we were both graduate students. We met while working together on a field project in Northern Alaska. Karl was studying the fish parasites from the large lake we were working around, and while we worked I explained that I had collected large numbers of soil samples from a series of privies that were linked to eighteenth-century artisan and petty merchant households in Newport, Rhode

Island. Our collaboration not only drove home the importance of parasite data as a window onto issues of health and disease (see Reinhard 1992, 1994; Reinhard et al. 1986), but also inspired later work that examined micro-environmental reconstruction of urban contexts (see Mrozowski 2006a, b).

I mention this episode because of the importance of collaboration in environmental archaeology. I would like to think that the conversations Karl and I had while working in Alaska helped us both in making cross-disciplinary collaboration a key component of our subsequent research. For me, building cross-disciplinary relationships has been a foundation stone of the Fiske Center for Archaeological Research that was established at the University of Massachusetts Boston in 1999. A good example of that work comes from research carried out with my Fiske Center colleagues Heather Trigg and John Steinberg that has drawn on a wealth of archaeoparasitological data from across eastern North America (see Trigg et al. 2017). This work provides a good example of posthumanist research in that its focus is on human–parasite interaction and the manner in which human behavior may have affected parasite health and distribution in North American cities between the seventeenth and early twentieth centuries. The study focuses on two of the most commonly encountered human parasites—*Trichuris trichiura,* better known as whipworm, and *Ascaris lumbricoides,* commonly called roundworm. *Trichuris trichiura* infects more than 800 million people today and is perhaps best known for sharing a close morphology with the pig parasite *Trichuris suis,* which is due in large measure to a long relationship between pigs and humans (see Nissen et al. 2012). *Ascaris lumbricoides* also remains an active disease vector, infecting close to a billion people a year where it thrives in wet, highly populated areas characterized by poverty and poor sanitation (Asaolu et al. 2017). Individuals are commonly infected from both parasites through the consumption of ova (eggs) located in contaminated soils, water or foods (Ash and Orihel 1990: 134–138).

Although infection from human parasites is much less common today than it was even 100 years ago, in the past it was a normal part of everyday life especially in highly urbanized areas. In their examination of parasite assemblages from primarily urban mid-Atlantic and Northeastern communities, Trigg (2017) and her colleagues found that there had been a shift in the prevalence of *Ascaris* eggs over that of *Trichuris* over time (Trigg and Jacobucci 2008). Other researchers had noted this shift (Leles et al. 2010; Taylor 1955), but the reasons behind it remained unclear. By examining a large data set from contexts dating to between the seventeenth and early twentieth centuries, Trigg and her colleagues were able to confirm the trend of *Ascaris's* eclipsing *Trichuris* over time that appears to coincide with the rapid growth of urbanized communities between 1800 and 1850 (Trigg et al. 2017: 521–522). Because each of the parasites need rather specific conditions in order to complete their reproductive cycles, the presence of their eggs in archaeological contexts can be used to reconstruct detailed pictures of micro-environments in the past. This proved to be of critical importance when Trigg and her colleagues asked what might be behind the shift from *Trichuris* to *Ascaris* in archaeological deposits. In their analysis of the results from 67 contexts recovered from seven different communities Trigg and her colleagues not only confirmed the shift from *Trichuris* to *Ascaris* but statistically pinpointed the period of most notable change as unfolding between 1800 and 1850, a period of rapid urbanization (2017: 521–527). Yet there was more to the explanation they provided than merely a growth in the density of urban populations during the first half of the nineteenth century. Indeed, the picture they reconstruct is a complex set of cultural and biological variables that together contributed to the change in patterns of parasite infection.

In summarizing their results Trigg and her colleagues stress that despite the microscopic scale of the parasite data they examined, it is larger patterns of land use affected by factors such as poverty, class and status more broadly that seem to be the critical variables behind the changes in parasite infection (2017: 530–531). The shift they identify is part of a much larger transformation of urban space that has roots going back millennia. The land use patterns in eighteenth-century cities such as Boston, New York, Philadelphia and Newport, Rhode Island represent the end of a long history that saw urban yard space used for a variety of purposes (Mrozowski 1991, 2006b). Whether it was for water and waste management, gardening, keeping animals or using yard space for work-related activities, the intensity of land use common in urban communities resulted in environments rife for the spread of disease. This is especially true of parasites such as *Trichuris* to *Ascaris,* whose reproductive cycles require time for their eggs to mature outside their human or animal hosts. Situations in which human and animal feces are present increases the opportunity for infection dramatically; however, the growth in *Ascaris* through time happens during a period when the nature of urban space is changing dramatically.

Throughout much of history urban communities have been a mix of commercial and residential space with the households of artisans making particularly intensive use of their surrounding yards. With the acceleration of urbanization during the nineteenth century, city landscapes become differentiated along class lines. What had been mixed neighborhoods composed of a variety of land uses and social classes were replaced by areas where work space and domestic space were becoming separated. One by-product of this transformation is the appearance of what we would define today as ornamental spaces—spaces no longer used for commercial or domestic purposes as had been common for centuries, but purely as expressions of status (see Mrozowski 2006a, b). In their analysis of the parasitological remains Trigg and her colleagues focus on the growth of urban heat islands and increasingly dryer urban soils linked to the appearance of ornamental spaces as major factors contributing to the drop in *Trichuris* eggs in archaeological contexts (2017: 531; see also Alcofardo and Andrade 2008; Maya et al. 2010). In instances such as this, factors such as income disparities appear to result in greater incidence of disease in poorer households—a pattern that remains a facet of many dimensions of health care and medicine in many countries today (see Asaolu et al. 2017; Bethony et al. 2006; Dodman et al. 2013; Underwood 2014; Sweet et al. 2013). Although high levels of infection are most common in poorer countries in primarily tropical environments, the patterns of spatial and environmental injustice seen in such contexts were clearly part of the nineteenth-century cities of North America and other Western countries. What these patterns reveal is the close and undeniable relationship that exists between human behavior and species, such as human parasites, whose co-evolution is inexorably linked.

The example of human parasites outlined above provides a strong example of how fruitless it is to view the past through a dualist perspective. In this regard it reinforces some of the underlying value of a posthumanist epistemology that seeks to stress the critical importance of human–nonhuman interaction through history. It also presents a case study that demonstrates the importance of examining the interaction of social and biological variables that is one of the hallmarks of the kind of environmental historical archaeology that is the central theme of this volume. The work summarized in Trigg et al. (2017) is one of what has been a growing number of studies that examine the intersection of the cultural and biological through an historical archaeology of the environment (Deagan 2008; Hardesty 1999, 2001, 2003, 2009; Mrozowski 2006a, b, 2010). Over the past decade there has been a steady increase in the studies that highlight the use of interdisciplinary techniques such as faunal and botanical analysis, phytolith and pollen analysis, analysis of insect remains, human and animal parasite remains as well as soil chemistry. What is perhaps most noteworthy is the manner in which such techniques are employed to examine the impact of colonialism on changing vegetation and landscapes more broadly (e.g., Astudillo 2017, 2018; Bouchard-Perron 2017; Bouchard and Bain 2009; Branton 2009; Faucher et al. 2017; Haberle 2003; Horrocks et al. 2008; Walker 2012). Allison Bain's analysis of insect remains, for example, provides one of the more ingenious ways of connecting the establishment of new biological communities as a direct outgrowth of large-scale processes such as colonialism (Bain 2000, 2005, 2010). The transportation of Old World species to the New World is only one facet of a larger picture that bridges the distance between global-scale processes and micro-level changes seen in the archaeological record. Other examples use data drawn from archaeological deposits to examine environmental change linked to complementary processes such as urbanization (e.g., Bain and Prévost 2010; Landon et al. 2016) and industry (Hardesty 2009; Hardesty and Fowler 2001; Murphy and Whiltshire 2002). One of the more interesting developments has been the use of environmental information to measure the impact industries such as the production of sugar cane has had on island ecologies (e.g., Astudillo 2017; Britt 2010; Maniketti 2015). Both Astudillo (2017, 2018) and Maniketti (2015) use a variety of environmental data sets to examine sugar cane production including the use of begasse—a by-product of sugar cane processing—used as a fuel (Britt 2010; Maniketti 2015) as well as the impact the industry has had on the stability of plant and animal communities. Astudillo's work (2017, 2018) is particularly noteworthy because of his intensive use of phytolith analysis, including his impressive development of phytolith analysis keys for his work in the Galapagos Islands.

3.3 Natures of Capitalism and Commodity Production

While the kinds of studies outlined above and those presented in this volume provide examples of the analytical value of environmental archaeology, it is the driving forces behind processes such as colonialism, urbanization and industrialization that

I want to focus upon here (Mrozowski 2006a, b, 2009). One of the more powerful ways of conceptualizing the biological dimensions of such large-scale, historical processes is to recast the notion of nature in the same manner argued by Arturo Escobar (1999) as "natures of capitalism." I have explored the use of this concept in a variety of contexts (see Mrozowski 2006a, b, 2009, 2010) and will return to this topic at the end of this chapter; however, I want to shift the focus in a different direction. Rather than provide additional examples of the impact processes such as industrialization have on the environment, I want to consider an equally, if not more important issue concerning the forces that lay behind the meteoric growth of Western capitalism and commodity production more broadly. And it is here that more traditional, material-culture-focused historical archaeology provides innumerable case studies that help in understanding the chronology (time) and geographical spread (space) of mass-produced items. It does this in many ways, through a combination of industrial archaeology that focuses on the technologies being used and the lives of the people using them. This extends to a whole host of examples of archaeological studies that examine consumer behavior from a variety of angles. For years historical archaeologists have marveled at just how widely products such as European and in particular English ceramics are recovered from even the most remote of locations across the earth (e.g., Barker and Majewski 2006; Cabek and Loring 1997; Brooks 2009; Gaulton and Casimiro 2015; Horning 2004; Mullins et al. 2013; Schavelzon 2005; Symonds 2013; Zarankin and Senatore 2005). They have also done extensive research on the use of ceramics in everyday life—their central place in the eating of food, either alone or with family members or in larger groups—and their role in the production and reproduction of identity (e.g., Brighton 2011; Brooks 1997, 2009; Burley 2003; Cochran and Beaudry 2006; Horning et al. 2007; Kelly 2008; Martin 1996; Martin et al. 2012; Middleton 2007; Mullins 1999, 2011; Pezzarossi 2014; Voss 2012; Wilkie and Farnsworth 1999).

Elsewhere I have outlined how new research being carried out in Europe is beginning to raise fundamental questions about the emergence of capitalism and its links to colonialism, imperialism and modernity (see Mrozowski 2018). Parts of this history are important for the argument I am trying to make here—that the cultural forces behind the growth of commodity production—the demand for such commodities—was part of a larger set of cultural practices that contributed to ideologies grounded in the idea that nature and culture were separate realities. It is these ideologies that continue to contribute to a lack of understanding of the connection between climate change and commodity production today. From an historical perspective there are two parts to the issue—first what drove the demand for commodities such as ceramics—and second how these items were integrated into everyday life. Rosa Luxemburg—who was an early critic of Marx's penchant for abstraction—wanted to know how the demand for consumer goods that had fueled the growth of capitalist economic regimes would be sustained if the laborers making those items could no longer afford to buy them (see Luxemburg 1951: 131–134; Mrozowski 2018). North American historical archaeologists have focused explicitly on questions surrounding demand—and production—in their discussions of the growth of capitalism between the seventeenth and nineteenth centuries (e.g., Leone 1995;

Leone and Shackel 1987; Leone and Knauf 2015; Leone and Potter Jr 1999; Matthews 2010; McGuire 1992, 2006; Mrozowski 2006b; Wurst 1999, 2015). European and British archaeologists have argued that the growth of consumer culture between the twelfth and sixteenth centuries helped in fueling nascent forms of capitalist production (Gaimster 2014; Horning and Schweickart 2016; Johnson 1996, 1999; Naum 2013, 2014; Naum and Nordin 2013; Herva and Nurmi 2009; Symonds 2013). Archaeological and historical evidence drawn from a variety of contexts supports the hypothesis that communities of merchants and artisans in Baltic countries, including Germany, Denmark, the Netherlands, Sweden, Finland, Russia, Poland, and what is today Latvia, Estonia and Lithuania, were part of a large network of production, exchange and consumption—known broadly as the Hanseatic League—that involved commercial practices, including complex contracts and book-keeping practices that can be classified as pre-capitalist in character (see Braudel 1982; DeLanda 1996, 1997; Fink 2011, 2012; Funnell and Robertson 2011; Gaimster 2014; Herva and Nurmi 2009; Naum 2013, 2014; Naum and Nordin 2013; Symonds 2013). One way of interpreting this combined work is to argue that the expanding demand for consumer products starting in the twelfth century helped to fuel subsequent economic expansion that was itself accelerated by European colonization starting in the fifteenth century; a formative moment in the growth of capitalism (Braudel 1982, 1985; Bolander and Johnson; 2018; Gaimster 2014; Horning 2018; Horning and Schweickart 2016; Johnson 1996, 1999, 2018; Naum 2013, 2014; Nurmi 2011; Naum and Nordin 2013; Orser Jr 2010; Wallerstein 1974, 1980, 1991).

Beyond documenting the global spread of classes of material culture, historical archaeologists have linked items such as ceramics and glassware to the larger-study of foodways—the cultural practices surrounding the production, preparation and consumption of food. I want to focus on two facets of this research to highlight what I believe are cultural practices that contributed to false notions of order and individualism that were reinforced in daily behavior. One of these, the analysis of material culture, is not often incorporated into environmental archaeological studies. The second—the classification and butchering of mammals, birds and fish—reveals a similar dimension of practice that also reinforces an ideological structure that sees humans and all other forms of life on the earth as somehow separate. In this regard they were and remain ideological structures that stand in the way of a posthuman, more sustainable future. Some of these ideas can be traced back to the work that James Deetz (1977, 1996) did with notions of order and symmetry reflected in foodways, architecture and mortuary art. Although Deetz never focused explicitly on economic issues or the work of Marx, he nevertheless argued that eating practices in the eighteenth century reflected the growth of individualism. Leone (1982, 1988) and others (Paynter 1988, 2000a, b; Little 1994; Schackel 1993) reinterpreted Deetz's original observations as part of the cultural practices associated with capitalism, especially the notion of individualism (see Leone and Potter Jr 1999; Matthews 2010; McGuire 2006; Mrozowski 2006a).

One of the more thought provoking dimensions of Deetz's original interpretations is his focus on order and symmetry. Deetz interpreted these material patterns from a structuralist perspective that he saw as part of a symmetrical "world view" based on the notion of an ordered universe. Again, Leone (1988), Shackel (1993) and Paynter (1988) interpreted these same patterns as indicative of an ideology that had deeper historical roots—than the eighteenth century—and which were part of the larger reconceptualization of all things material—space, animals, enslaved peoples, the body—as commodities for personal use and consumption (see Mrozowski 1999, 2006a). This was not the only alternative or complementary interpretation offered by historical archaeologists or historians concerning patterns of consumption. Many have focused on other interpretive tropes such as gentility, respectability or modernity in linking patterns of consumption to larger ideological structures Regardless of which trope one employs or what class of empirical evidence one examines, there seems to be a general consensus that the use of matched sets of dinner wares reproduced a symmetry that was part of a larger set of cultural practices whose popularity spread rapidly during the eighteenth century but was part of a larger trajectory characterized as modernity (see Beaudry and Mehler 2016). I believe that facets of these cultural practices—especially the emphasis on symmetry—can be traced to Renaissance Italy (Mrozowski 1999, 2006b) but are also part of the growth in consumer goods now being documented by historical archaeologists in Europe.

One of the more ingenious facets of Deetz's (1977) original formulation of what he called "the Georgian Mind-Set" was his focus on individualism in foodways. Historical archaeologists working in a variety of contexts have employed this same notion of Georgianization in their own interpretations of foodways, landscapes and architecture (e.g., Bell 2002; Johnson 1993, 1996; Leone 1988, 1999; Martin 1994; Miller et al. 1994). Although not all agree with the origin of these patterns or Deetz's overall interpretation, they nevertheless agree that patterns he identified are real and widespread. In most instances archaeologists who have examined the notion of Georgian cultural practices have focused primarily on material culture. Yet Deetz (1977) also argued that butchering techniques that were designed to reproduce particular cuts of meat was an equally important part of the patterns he identified. Subsequent research by zooarchaeologists helped to refine Deetz's original interpretation by focusing more on the commercialization of food (e.g., Bowen 1994, 1999; Landon 1996). More recent zooarchaeological research has sought to recast the interpretation of butchering patterns of animals as indicative of commodification and modernity (e.g., Hambrecht 2009, 2012; Puputti 2008, 2010; Mrozowski 1999, 2009). The work by Hambrecht and Puputti is both enlightening and important because it helps to identify patterns of animal processing that are indicative of both instrumentality and notions of modernity. In both instances Hambrecht (2009, 2012) and Puputti (2008, 2010) are able to identify patterns of animal processing that demonstrate a high level of uniformity that was linked to highly developed commercial practices in what would normally be considered "pre-capitalist" cultural contexts in Iceland and Finland, respectively. In Iceland Hambrecht (2012) has suggested that the uniformity in butchering and processing of mammals and fish he identified empirically reveals what he calls "modern" patterns of commercialization that I would suggest are linked to nascent forms of capitalism linked to German merchants and the Hanseatic League.

Combined with the host of classes of material culture, the zooarchaeological evidence of uniformity and instrumentality linked to modern commercial practices provides strong empirical evidence of a performative materiality easily adapted to any number of interpretations of modernity. This would have been particularly true of performative mediums such as dining, landscapes and gardens, as well as architecture. And I believe Deetz was correct when he argued that cultural practices such as formal dining were expressions of order and symmetry in the universe. Yet I would argue that the material representations of order and symmetry Deetz correctly identified were, and remain part of, a human-centered, "humanist" ideological structure that is completely and utterly false. The same instrumentality visible in the butchering of animals and fish in early modern Iceland and Finland are examples of the process of commodification that is itself part of the larger emergence of capitalism.

There is, however, another level of analysis and reflection that is equally if not more important. And that is examining the manner in which the material world helps in masking biosocial realties by creating a false notion of order and symmetry through myriad classes of material culture. Whether one is dealing with landscapes such as gardens, or architecture, scientific measuring instruments, eating utensils or any number of classes of material culture, there is ample evidence to support the notion that their associated cultural practices reproduce a false notion of symmetry that helps in promoting the idea that social inequalities are the product of natural law (see Johnson 1993, 1996; Leone 1988, 1995; Leone and Potter Jr 1999; Matthews 2010: 57–84; Mrozowski 1996, 1999, 2006a, b, 2018; Shackel 1993). Many of the commodities that fueled the reproduction of a symmetrical, human-centered world were categories of products that helped in fueling the growth of mechanized production. And that is why it is important that the factors driving the acceleration of commodity production be given the same level of consideration as the impact factory-based mass production has had on the environment. They are, as it is often said, two sides of the same coin. And as such it means that we need to focus our intellectual gaze on both the environment and the labor of those whose work is linked to commodity production that may not be sustainable. It took close to a millennium to build the capacity to flood the world with commodities, to say nothing of the ideological architecture necessary to promote demand on such a global scale. If more than 50 years of concerted research in historical archaeology has told us anything it is that the explosion in commodity production that emerged at the confluence of colonialism, urbanization, industrialization and the growth of a humanist/modernist ideology has masked the impact those activities have had on the earth's ecosystem. It would be one thing if we were only looking to the past in our attempts to understand the breadth of these interrelated histories. Then we might be excused from asking questions concerning the future. But we can make no such claim. The overall trajectory of commodity production and global warming is undeniable to the point where one has to wonder how much more documentation is needed to support the overall patterns that climate specialists have identified. Instead we should be using our understanding of how we got to this point and pivoting to the future in an effort to identify critical issues to begin considering now.

3.4 Conclusion: Archaeologies of the Future

I want to apologize if I have overstated any of these final points or failed to provide the kind of documentation that might be warranted. But I think that the overall patterns of material culture production and use over the past 500–700 years provides evidence of an overall trajectory that is consistent and visible in numerous case studies, albeit mainly Western, colonial or postcolonial contexts. These studies have been complemented by others that have looked expressly at the environment in their research. Together they provide a rich collection of case studies that document the multi-scalar intersection between the cultural and biological dimensions of large-scale historical processes such as colonialization, urbanization, industrialization and globalization. These processes differ in both scale and substance in comparison with an idea such as modernity. The latter represents a set of ideological expectations with their own materialities which differ from context to context. Processes such as colonization and urbanization had their own ideological dimensions; but unlike modernity, they were realized through physical engagement with new environments filled with people who had very different perceptions and histories. Is there a single analytical framework that can accommodate the scale of these differences and experiences? I would argue that the epistemologies of political ecology and posthumanism offer good candidates. Each attempts to overcome the human-centered ontologies of many sciences and humanist pursuits, including archaeology. In doing so these approaches tend to offer perspectives that examine human behavior as part of a larger set of relationships. Having said that I want to break a cardinal rule of posthumanism and focus squarely on humans and the threat they pose to all other forms of life on the earth as part of an archaeology of the future.

Doing an archaeology of the future can take several forms (see Mrozowski 2014; Sassaman 2010, 2012; Wurst and Mrozowski 2014), but here I want to focus on the notion that past is prologue to future. This idea, discussed in detail by Bertel Ollman (2003, 2014), argues that it is possible to examine the past with an eye toward imagining a variety of futures beyond that which actually has unfolded. At a deeper level it argues for the notion that history has as many pasts as it does potential futures. If one accepts the notion that past is prologue to the future then it should be possible to use the past as a vantage point from which to examine a series of potential futures. During the course of conducting archaeological field work in Lowell, Massachusetts, during the late 1980s and 1990s (Beaudry and Mrozowski 2001; Mrozowski 2006a, b; Mrozowski et al. 1996), the discovery of items made of plastics from contexts dating to the 1870s and 1880s was not initially linked to events such as political tensions between the United States and the oil-rich nations of western Asia. With the help of Ollman's (2003, 2014) perspective on linking pasts and futures it was possible to reinterpret the early use of plastics as part of a much larger transformation in the world economy that was in its infancy in the late nineteenth century (see Mrozowski 2014). From that vantage point it was also possible to ask why no one could have possibly envisioned that less than a century later oil would be so important that it would lead to conflicts that continue to haunt the planet today.

Pivoting to the future from the vantage point of the past is a useful and salutary exercise albeit not necessarily in every instance. What is most important is that archaeologists of both the recent and deep pasts must endeavor to address questions concerning the intersection of the cultural and biological in history. And in most instances, these are best focused squarely on the past and not necessarily needing to pivot to the future. If, however, the goal IS to focus on the future, then perhaps it is best to take the widest interpretive lens. In this case it is to argue that historical archaeologists have done a fine job of documenting the intersection of the micro and macro-level spatial scales at the same time as having laid bare the close connections between forces such as colonialism and the resulting transformation of the biotic communities on the earth. The massive acceleration in commodity production starting in the 18th century provided employment for rapidly growing European and North American populations. It also set in motion a series of climatological changes that would contribute directly to the global warming the planet now is experiencing. The interwoven character of these two processes—the growth in employment in commodity production and the impact industrial production has had on the climate of the earth—make them doubly difficult to address because of the causal relationship they share. With so many of the world's population, especially the least educated members of society, working in commodity production, how do we address the economic issues that are sure to challenge attempts to curtail industrial production?

Part of the problem is the manner in which cultural expectations have been linked to materialities supported by commodity production. Since most of the items produced are linked to domestic life and the construction and communication of identity, humans may have to explore new ways of thinking about a whole host of cultural practices that are part of a contemporary doxa. One of these is how human value will be measured and in particular the nature of human labor and work. With the growth of automation and the potential curtailment of commodity production, what will humans do? What will bring worth to their lives? How will they be supported? Isn't it time to give serious thought to new economic and social models to replace the capitalist economies that dominate the earth at the moment.

These are not trivial questions, nor should we expect to find answers to them in the pasts we examine in our research. Rather than focus only on how the process of commodification has transformed much of the world's resources into items for exchange, I would argue we need to ask what it masks—the false world it has helped humans construct and how the ideologies that form the architecture of those perceptions has blinded humans to the irreplaceable nature of their environment. The false order that has been reproduced materially through commodities has driven the world perilously close to an irreversible calamity. So precisely what can an environmental historical archaeology do to unmask these false materialities and demonstrate the dependencies that entangle all life on the planet? Most importantly it needs more case studies that focus on these dependencies and the close connections that exist between social and biological variables. Not all of these need to be case studies that look at the biological dimensions of human problems such as poverty, racism and income disparities, although these are obviously good examples of questions researchers are already examining. It is equally important to place smaller-scale, localized examples into broader contexts that reveal regional or local trends. Most importantly, it is critical that we appreciate the importance of time as a factor in understanding how large-scale problems—such as pollution or climate change—are the product of slower, cumulative processes that are not easy to document. That is perhaps archaeology's greatest contribution to the topic as a whole—our wonderful ability to examine long periods of time over large spaces. When taken as a whole, the cumulative evidence gathered by historical archaeologists provides ample evidence of the depths of the challenges that face humanity and some of the reasons that many governments remain resistant to even considering the scale of changes necessary to chart a more sustainable future.

References

Alcoforado, M. J., & Andrade, H. (2008). Global warming and urban Heat Island. In J. Marzluff, E. Shulenberger, W. Endlicher, M. Alberti, G. Bradley, C. Ryan, C. ZumBrunnen, & U. Simon (Eds.), *Urban ecology: An international perspective on humans and nature* (pp. 249–262). Boston: Springer.

Asaolu, O. A., Ofozie, O. E., & Onyeji, O. C. (2017). *Ascaris lumbricoides*. http://www.antimicrobe.org/b17.asp. Accessed 1 Feb 2018.

Ash, L., & Orihel, T. (1990). *Atlas of human parasitology*. Chicago: American Society of Clinical Pathologists Press.

Astudillo, F. J. (2017). Environmental historical archaeology of the Galápagos Islands: Paleoethnobotany of Hacienda El Progreso, 1870–1904. Doctoral Dissertation, Department of Archaeology, Simon Frazer University.

Astudillo, F. J. (2018). Soil Phytoliths as indicators of initial human impact on San Cristóbal Island Galápagos. *Paleoteography, Palaeoclimatology, Palaeocology, 490*, 522–532.

Baert, P. (2005). *Philosophy of the social sciences: Toward pragmatism*. Cambridge: Polity Press.

Bain, A. (2000). *Archaeoentomological and archaeoparasitological reconstructions at Îlot Hunt (CeEt-110): New perspectives in historical archaeology (1850–1900)*, *British Archaeological Reports* (Vol. S973). Oxford: Archaeopress.

Bain, A. (2005). Irritating intimates: The archaeoentomology of lice, fleas, and bedbugs. *Northeast Historical Archaeology, 33*, 81–90.

Bain, A. (2010). An introduction to environmental and economic archaeologies of missions, colonies and plantations. *Historical Archaeology, 44*(3), 1–3.

Bain, A., & Prévost, M. A. (2010). Environmental archaeology and landscape transformation at the 17th-century Ferryland Site, Newfoundland. *Historical Archaeology, 44*(3), 21–35.

Balée, W. L. (1998). *Advances in historical ecology*. New York: Columbia University Press.

Balée, W. L. (2006). The research program of historical ecology. *Annual Review of Anthropology, 35*(1), 75–98.

Balée, W. L., & Erickson, C. L. (2006). *Time and complexity in historical ecology: Studies in the neotropical lowlands*. New York: Columbia University Press.

Barker, D., & Majewski, T. (2006). Ceramic studies in historical archaeology. In D. Hicks & M. C. Beaudry (Eds.), *The Cambridge companion to historical archaeology* (pp. 205–231). Cambridge: Cambridge University Press.

Beaudry, M. C., & Mrozowski, S. A. (2001). Cultural space and worker identity in the Company City: Nineteenth-century Lowell, Massachusetts. In A. Mayne & T. Murray (Eds.), *The archaeology of urban landscapes: Explorations in slumland* (pp. 118–131). Cambridge: Cambridge University Press.

Beaudry, M.C. & N. Mehler (2016) Post-Medieval Archaeology, 50(1), 108–120.

Bell, A. (2002). Emulation and empowerment: Material, social, and economic dynamics in eighteenth- and nineteenth-century Virginia. *International Journal of Historical Archaeology, 6*(4), 253–298.

Benton, T. (Ed.). (1996). *The greening of Marxism*. New York: Guilford Press.

Bethony, J., Brooker, S., Albonico, M., Geiger, S. M., Loukas, A., Diemert, D., & Hotez, P. J. (2006). Soil-transmitted helminth infections: Ascariasis, Trichuriasis, and Hookworm. *The Lancet, 367*(9521), 1521–1532.

Biersack, A., & Greenberg, J. B. (2006). *Reimagining political ecology*. Durham: Duke University press.

Bolander, D. J., & Johnson, E. D. (2018). Reassembling the household for icelandic archaeology: A contribution to comparative political economy. *Post Medieval Archaeology, 51*(1) in press.

Bouchard-Perron, J. A. (2017). Savage lands, civilizing appetites: Power and winderness in Quebec City (1535-1900). *American Antiquity, 82*(3), 480–497.

Bouchard-Perron, J. A., & Bain, A. (2009). From myth to reality: Archaeobotany at the Cartier Roberval Upper Fort site. *Post-Medieval Archaeology, 43*, 87–105.

Bowen, J. (1994). A comparative analysis of the New England and Chesapeake herding systems. In P. A. Shackel & B. J. Little (Eds.), *Historical Archaeology of the Chesapeake* (pp. 155–167). Washington D.C: Smithsonian Institution Press.

Bowen, J. (1999). The Chesapeake landscape and the ecology of animal husbandry. In G. Egan & R. L. Michael (Eds.), *Old and new worlds* (pp. 358–367). Oxford: Oxbow.

Braidotti, R. (2013). *The posthuman*. Cambridge: Polity Press.

Braidotti, R. (2016). Posthuman critical theory. In D. Banerji & M. R. Paranjape (Eds.), *Critical posthumanism and planetary futures* (pp. 13–32). London: Springer.

Branton, N. (2009). Landscape approaches in historical archaeology: The archaeology of places. In D. Gaimster & T. Majewski (Eds.), *International handbook of historical archaeology* (pp. 51–65). New York: Springer.

Braudel, F. (1982). *Civilization and capitalism 15th–18th century, Vol. II: Wheels of commerce*. New York: Harper and Row.

Braudel, F. (1985). *Civilization and capitalism 15th–18th century, Vol. III: The perspective of the world*. New York: Harper and Row.

Brighton, S. A. (2011). Middle-class ideologies and American respectability: Archaeology and the Irish immigrant experience. *International Journal of Historical Archaeology, 15*(1), 30–50.

Britt, S. F. (2010). Fueling the fire: Examining Caribbean colonial relations between humans and the environment. *Historical Archaeology, 44*(3), 54–68.

Brooks, A. (1997). Beyond the fringe: Transfer–printed ceramics and the internationalization of Celtic myth. *International Journal of Historical Archaeology, 1*(1), 39–55.

Brooks, A. (2009). The view from afar: International perspectives on the analysis of post-1750 ceramics in Britain and Ireland. In A. Horning & M. Palmer (Eds.), *Crossing paths or sharing tracks: Future directions in the archaeological study of post-1550 Britain and Ireland* (pp. 287–300). Woodbridge: Boydell & Brewer.

Burley, D. V. (2003). Toward the historical archaeology of Levuka, a South Pacific port of call. *International Journal of Historical Archaeology, 7*(4), 243–265.

Butler, J. (1993). *Bodies that matter: On the discursive limits of sex*. New York: Routledge.

Cabek, M., & Loring, S. (1997). 'A set of very fair cups and saucers': Stamped ceramics as an example of Inuit incorporation. *International Journal of Historical Archaeology, 4*(1), 1–34.

Chakrabarty, D. (2009). The climate of history: Four theses. *Critical Enquiry, 35*, 197–222.

Chakrabarty, D. (2012). Postcolonial studies and climate change. *New Literary History, 43*, 1–18.

Comstock, A. R. & R. A. Cook (2017) Climate change and migration along a Mississippian periphery: fort ancient example. American Antiquity 83(1), 91–108.

Cochran, M.D. & M.C. Beaudry (2006) Material culture studies and historical archaeology. In Hicks, D. & M.C. Beaurdy (eds.) The Cambridge Companion to Historical Archaeology, pp. 191–204, Cambridge, Cambridge University Press.
Crosby, A. W. (1986). *Ecological imperialism: The biological expansion of Europe, 900–1900*. Cambridge/New York: Cambridge University Press.
Crumley, C. L. (1994). *Historical ecology: Cultural knowledge and changing landscapes*, *School of American Research advanced seminar series*. Seattle: School of American Research Press.
Crumley, C. L. (2003). Historical ecology: Integrated thinking at multiple temporal and spatial scales. In A. Hornborg & C. Crumley (Eds.), *The world system and the earth system: Global socioenvironmental change and sustainability since the Neolithic* (pp. 15–28). Walnut Creek: Left Coast Press.
De Souza, M. C. (2014). Descola's beyond nature and culture, viewed from Central Brazil. *HAU: Journal of Ethnographic Theory, 4*(3), 419–429.
Deagan, K. A. (1996). Environmental archaeology and historical archaeology. In E. J. Reitz, L. A. Newsom, & S. J. Scudder (Eds.), *Case studies in environmental archaeology* (pp. 339–358). New York: Plenum Press.
Deagan, K. A. (2008). Environmental archaeology and historical archaeology. In E. J. Reitz, S. J. Scudder, & C. M. Scarry (Eds.), *Case studies in environmental archaeology*, *Interdisciplinary contributions to archaeology* (pp. 21–42). New York: Springer.
Deetz, J. (1996) In small things forgotten: The archaeology of early American life, revised edition, New York, Anchor Books.
Deetz, J. (1977). *In small things forgotten: The archaeology of early American life*. Garden City: Anchor Press.
DeLanda, M. (1996). Markets and antimarkets in the world economy. In S. Aronowitz, B. Martinsons, & M. Menser (Eds.), *Technosciene and Cyberculture* (pp. 181–194). New York: Routledge.
Delanda, M. (1997). *A thousand years of nonlinear history*. Brooklyn: Zone Books.
Descola, P. (2013). *Beyond nature and culture*. Chicago: University of Chicago Press.
Descola, P., & Pàlsson, G. (Eds.). (1996). *Nature and society: Anthropological perspectives*. London: Routledge.
Dew, K. (2012). *The cult and science of public health: A sociological investigation*. Oxford: Berghan Books.
Dew, K., Scott, A., & Kirkman, A. (2016). *Social, political and cultural dimension of health*. New York: Springer.
Diamond, J. (1998). *Germs, guns and steel: The fates of human societies*. W.W Norton and Company: New York.
Dodman, D., Brown, D., Francis, K., Hardoy, J., Johnson, C., & Satterthwaite, D. (2013). Understanding the nature and scale of urban risk in low- and middle-income countries and its implications for humanitarian preparedness, planning and response. *Human Settlements Discussion Paper Series: Climate Change and Cities* 4. International Institute for Environment and Development, London.
Escobar, A. (1999). After nature: Steps to an anti-essentialist political ecology. *Current Anthropology, 40*(1), 1–30.
Escobar, A. (2008). *Territories of difference: Place, movements, life, redes*. Durham: Duke University Press.
Faucher, A. M., Bain, A., & Grimes, V. (2017). First archaeological evidence for old world crops in the Caribbean: The presence of barley on the Island of Barbuda. *Historical Archaeology, 51*(4), 542–556.
Fink, A. (2011). Under what conditions may social contracts arise? Evidence from The Hanseatic League. *Constitutional Political Economy, 22*(2), 173–190.
Fink, A. (2012). The Hanseatic League and the concept of functional overlapping competing jurisdictions. *Kyklos, 65*(2), 194–217.
Funnell, W., & Robertson, J. (2011). Capitalist accounting in sixteenth-century Holland. *Accounting, Auditing & Accountability Journal, 24*(5), 560–586.

Gaimster, D. (2014). The Hanseatic cultural significance: Exploring globalization on the micro-scale in Late Medieval Northern Europe. *Journal of European Archaeology, 17*(1), 60–81.
Gaulton, B. C., & Casimiro, T. M. (2015). Custom made ceramics, trans-Atlantic business partnerships and entrepreneurial spirit in early modern New Foundland: An examination of the SK vessels from Ferryland. *International Journal of Historical Archaeology, 19*(1), 1–20.
Geismar, J. H. (1993). Where is the night soil? Thoughts on an urban privy. *Historical Archaeology, 27*(2), 57–70.
Haberle, S. G. (2003). Late quaternary vegetation dynamics and human impact on Alexander Selkirk Island, Chile. *Journal of Biogeography, 30*(2), 239–255.
Hambrecht, G. (2009). Zooarchaeology and the archaeology of early modern Iceland. *Journal of the North Atlantic, 2*, 3–22.
Hambrecht, G. (2012). Zooarchaeology and modernity in Iceland. *International Journal of Historical Archaeology, 16*, 472–487.
Hambrecht, G., & Rockman, M. (2017). International approaches to climate change and heritage. *American Antiquity, 82*(4), 627–641.
Haraway, D. (1991). *Simians, cybords, and women: The reinvention of nature*. New York: Routledge.
Haraway, D. (2003). *The companion species manifesto: Dogs, people, and significant otherness*. Chicago: University of Chicago Press.
Hardesty, D. L. (1999). Historical archaeology in the next millennium: A forum. *Historical Archaeology, 33*(3), 51–58.
Hardesty, D. L. (2001). Archaeology. In M. K. Tolba (Ed.), *Our fragile world: Challenges and opportunities for sustainable development* (Vol. II, pp. 1,165–1,181). Oxford: Eolss Publishers.
Hardesty, D. L. (2003). Mining rushes and landscape learning in the modern world. In M. Rockman & J. Steele (Eds.), *Colonization of unfamiliar landscapes: The archaeology of adaptation* (pp. 81–95). London: Routledge.
Hardesty, D. L. (2009). Historical archaeology and the environment: A north American perspective. In D. Gaimster & T. Majewski (Eds.), *International handbook of historical archaeology* (pp. 67–75). New York: Springer.
Hardesty, D. L., & Fowler, D. D. (2001). Archaeology and environmental changes. In C. Crumley (Ed.), *New directions in anthropology and environment* (pp. 72–89). Walnut Creek, California: AltaMira Press.
Harris, O., & Cipolla, C. (2017). *Archaeological theory in the new millennium*. New York: Routledge.
Herva, V. P., & Nurmi, R. (2009). Beyond consumption functionality, artifact biography, and early modernity in a European periphery. *International Journal of Historical Archaeology, 13*(2), 158–182.
Horning, A. (2004). Archaeological explorations of cultural identity and rural economy in the North of Ireland: Goodland, County Antrim. *International Journal of Historical Archaeology, 8*(3), 199–215.
Horning, A. (2018). Minding the gaps: Exploring the intersection of political economy, colonial ideologies, and cultural practices in Early Modern Ireland. *Post-Medeival Archaeology, 51*(1) in press.
Horning, A., & Schweickart, E. (2016). Globalisation and the spread of capitalism: Material resonances. *Post-Medieval Archaeology, 50*(1), 34–52.
Horning, A., Baoill, R. Ó., Donnelly, C., & Logue, P. (Eds.). (2007). *The post-medieval archaeology of Ireland 1550–1850*. Dublin: Wordwell.
Horrocks, M., Smith, I. W. G., Nichol, S. L., & Wallace, R. (2008). Sediment, soil and plant microfossil analysis of Maori gardens at Anaura Bay, eastern North Island, New Zealand: Comparison with descriptions made in 1769 by Captain Cook's expedition. *Journal of Archaeological Science, 35*(9), 2446–2464.
Johnson, M. (1993). *Housing culture*. London: University College of London Press.
Johnson, M. (1996). *An archaeology of capitalism*. Oxford: Blackwell Publishers.

Johnson, M. (1999). Historical, archaeology, capitalism. In M. P. Leone & P. B. Potter Jr. (Eds.), *Historical archaeologies of capitalism* (pp. 219–232). New York: Kluwer.

Johnson, M. (2018) Geography, political economy and the 'personality of Britain'. Post-Medieval Archaeology, 51(1) in press.

Kelly, K. G. (2008). Creole cultures of the Caribbean: Historical archaeology in the French West Indies. *International Journal of Historical Archaeology, 12*(4), 388–402.

Kintigha, K. W., Altschulb, J. H., Beaudry, M. C., Drennand, R. D., Kinzige, A. P., Kohlerf, T. A., Limph, W. F., Maschneri, H. D. G., Michenerj, W. K., Pauketatk, T. R., Peregrineg, P., Sabloff, J. A., Wilkinsonm, T. J., Wright, H. T., & Zedero, M. A. (2014). Grand challenges for archaeology. *American Antiquity, 79*(1), 5–24.

Landon, D. B. (1996). Feeding Colonial Boston: A Zooarchaeologial Study. *Historical Archaeology, 30*(1), 1–153.

Landon, D., Trigg, H., Bain, A., & Morin, E. (2016). Urbanization and landscape change in early-eighteenth century Boston: The environmental archaeology of Town Dock. *Historical Archaeology, 50*(1), 80–93.

Leles, D., Reinhard, K., Fugassa, M., Ferreira, L. F., Iñiguez, A. M., & Araújo, A. (2010). A parasitological paradox: Why is ascarid infection so rare in the prehistoric Americas? *Journal of Archaeological Science, 37*(7), 1510–1520.

Leone, M. P. (1982). Some opinions about recovering mind. *American Antiquity, 47*, 742–760.

Leone, M. P. (1988). The Georgian order as the order of merchant capitalism in Annapolis, Maryland. In M. P. Leone & P. B. Potter (Eds.), *The recovery of meaning: Historical archaeology in the Eastern United States* (pp. 235–261). Washington, D.C.: Smithsonian Institution Press.

Leone, M. P. (1995). Historical archaeology of capitalism. *American Anthropologist, 97*(2), 251–268.

Leone, M. P., & Knauf, J. E. (Eds.). (2015). *Historical archaeologies of capitalism* (Second ed.). New York: Springer.

Leone, M. P., & Potter, P. B., Jr. (Eds.). (1999). *Historical archaeologies of capitalism*. New York: Kluwer.

Leone, M. P., & Shackel, P. A. (1987). Forks, clocks, and power. In D. W. Ingersoll & G. Bronitsky (Eds.), *Mirror and metaphor* (pp. 44–61). University Press of America: Lanham.

Little, B. J. (1994). People with history: An update on historical archaeology in the United States. *Journal of Archaeological Method and Theory, 1*, 5–40.

Luxemburg, R. (1951). *The accumulation of capital*. London: Routledge and Kegan.

Maniketti, M. G. (2015). *Sugar cane capitalism and environmental transformation: An archaeology of colonial Nevis, West Indies*, *Caribbean archaeology and ethnohistory*. Tuscaloosa: The University of Alabama Press.

Martin, A. S. (1994). "Fashionable sugar dishes, latest fashion ware" The creamware revolution in the eighteenth –century Chesapeake. In P. A. Shackel & B. J. Little (Eds.), *Historical archaeology of the Chesapeake* (pp. 169–187). Washington D.C: Smithsonian Institution Press.

Martin, A. S. (1996). Frontier boys and country cousins: The context for choice in eighteenth-century consumerism. In L. A. De Cunzo & B. L. Herman (Eds.), *Historical archaeology the study of American culture* (pp. 71–102). Knoxville: The Henry Francis du Pont Winterthur Museum, University of Tennessee Press.

Martin, J. G., Brooks, A., & Lima, T. A. (2012). Crossing borders and maintaining identity: Perspectives on current research in South American historical archaeology. *Historical Archaeology, 46*(3), 1–15.

Matthews, C. N. (2010). *The archaeology of American capitalism*. Gainesville: University Press of Florida.

Maya, C., Ortiz, M., & Jiménez, B. (2010). Viability of *Ascaris* and other helminth genera nonlarval eggs in different conditions of temperature, lime (pH) and humidity. *Water Science and Technology, 62*(11), 2616.

McGuire, R. H. (1992). *A Marxist archaeology*. New York: Academic Press.

McGuire, R. H. (2006). Marxism and capitalism in historical archaeology. In D. Hicks & M. C. Beaudry (Eds.), *The Cambridge companion to historical archaeology* (pp. 123–142). Cambridge: Cambridge University Press.
Middleton, A. (2007). Silent voices, hidden lives: Archaeology, class and gender in the CMS Missions, Bay of Island, New Zealand, 1814-1845. *International Journal of Historical Archaeology, 11*(1), 1–31.
Miller, G. L., Martin, A. S., & Dickerson, N. S. (1994). Changing consumption patterns, English ceramics and the American market from 1770 to 1840'. In K. Hutchens (Ed.), *Everyday life in the early republic, 1770–1828* (pp. 219–246). New York: W.W. Norton.
Mrozowski, S.A. (1991) Landscapes of Inequality. In R.H. McGuire and R. Paynter (eds.) The Archaeology of Inequality (79–101). Oxford, Blackwell.
Mrozowski, S. A. (1996). Nature, society, and culture: Theoretical considerations in historical archaeology. In L. A. De Cunzo & B. L. Herman (Eds.), *Historical archaeology the study of American culture* (pp. 447–473). Knoxville: The Henry Francis du Pont Winterthur Museum, University of Tennessee Press.
Mrozowski, S. A. (1999). The commodification of nature. *International Journal of Historical Archaeology, 3*(3), 153–166.
Mrozowski, S. A. (2006a). *The archaeology of class in urban America*. Cambridge: Cambridge University Press.
Mrozowski, S. A. (2006b). Environments of history: Biological dimensions of historical archaeology. In M. Hall & S. Silliman (Eds.), *Historical archaeology* (pp. 23–41). Oxford: Blackwell.
Mrozowski, S. A. (2009). Pulling the threads together: Issues of theory and practice in an archaeology of the modern world. In A. Horning & M. Palmer (Eds.), *Crossing paths or sharing tracks? Future directions for the archaeological study of Post-1550 Britainand Ireland*, *Society for post-medieval achaeology monograph series* (Vol. 5, pp. 381–396). Woodebridge: Boydell and Brewer.
Mrozowski, S. A. (2010). New and forgotten paradigms: The environment and economics in historical archaeology. *Historical Archaeology, 44*(3), 117–127.
Mrozowski, S. A. (2012). Ethnobiology for a diverse world: Spaces and natures: Archaeology and the political ecology of modern cities. *Journal of Ethnobiology, 32*(2), 129–133.
Mrozowski, S. A. (2014). Imagining an archaeology of the future: Capitalism and colonialism past and present. *International Journal of Historical Archaeology, 18*(2), 340–360.
Mrozowski, S. A. (2018). Reimagining political economy as a foundation for archaeologies of the past, present and future. *Post-Medieval Archaeology, 51*(1) in press.
Mrozowski, S. A., Bell, E. L., Beaudry, M. C., Landon, D. B., & Kelso, G. K. (1989). Living on the Boott: Health and well being in a boardinghouse population. *World Archaeology, 21*(2), 298–319.
Mrozowski, S. A. G., Zeising, H., & Beaudry, M. C. (1996). *Living on the Boott historical archaeology at the Boott Mills Boardinghouses, Lowell, Massachusetts*. Amherst: University of Massachusetts Press.
Mullins, P. (1999). Race and genteel consumer: Class and African-American consumption, 1850–1930. *Historical Archaeology, 33*, *22–38*.
Mullins, P. (2011). *The archaeology of consumer culture*. Tallahassee: University of Florida Press.
Mullins, P. R., Ylimaunu, T., Brooks, A., Kallio-Seppä, T., Kuorelehto, M., Nurmi, R., Oikarinen, P., Herva, V. P., & Symonds, J. (2013). British ceramics on the northern European periphery: Creamware marketing in nineteenth-century Finland. *International Journal of Historical Archaeology, 17*(4), 632–650.
Murphy, P., & Wiltshire, P. E. J. (2002). *The environmental archaeology of industry*. Oxford: Oxbow.
Naum, M. (2013). Premodern translocals: German merchant diaspora between Kalmar and Northern German towns (1250–1500). *International Journal of Historical Archaeology, **17***(2), 376–400.
Naum, M. (2014). Multi-ethnicity and material exchanges in late medieval Tallinn. *European Journal of Archaeology, 17*(4), 656–677.

Naum, M., & Nordin, J. M. (Eds.). (2013). *Scandinavian colonialism and the rise of modernity: Small time agents in a global arena*. New York: Springer.

Nissen, S., Al-Jubury, A., Hanson, T. V. A., Olsen, A., Christensen, H., Thamsborg, S. M., & Nejsum, P. (2012). Genetic analysis of Trichuris suis and Trichuris trichiura recovered from humans and pigs in a sympatric setting in Uganda. *Veterinary Parasitology, 188*, 68–77.

Nurmi, R. (2011). Development of the urban mind—an object biological approach: The case study of the Town of Tornio, Northern Finland. Doctoral Dissertation, Faculty of Humanities, Oulu: University of Oulu.

O'Conner, J. (1998). *Natural causes: Essays in ecological Marxism*. New York: Guilford.

Ollman, B. (2003). *Dance of the dialectic: Steps in Marx's method*. Urbana: University of Illinois Press.

Ollman, B. (2014). Historical archaeology, dialectical materialism, or ufug studies? *International Journal of Historical Archaeology, 18*(2), 361–373.

Orser, C. E., Jr. (2010). Twenty-First century historical archaeology. *Journal of Archaeological Research, 18*, 111–150.

Paynter, R. (1988). Steps to an archaeology of capitalism: Material culture and class analysis. In M. P. Leone, B. Parker, & P. Jr (Eds.), *The recovery of meaning: Historical archaeology in the Eastern United States* (pp. 407–433). Washington, D.C.: Smithsonian Institution Press.

Paynter, R. (2000a). Historical and anthropological archaeology: Forging alliances. *Journal of Archaeological Research, 8*(1), 1–37.

Paynter, R. (2000b). Historical archaeology and the post-columbian world of North America. *Journal of Archaeological Research, 8*(3), 169–217.

Pezzarossi, G. (2014). Camouflaging consumption and colonial mimicry: The materiality of a colonial Nipmuc household. *International Journal of Historical Archaeology, 18*(1), 146–174.

Preucel, R. W., & Bauer, A. A. (2001). Archaeological pragmatics. *Norwegian Archaeological Review, 34*, 85–96.

Pruecel, R. W., & Mrozowski, S. A. (Eds.). (2010). *Contemporary archaeology in theory: The new pragmatism*. Malden: Wiley-Blackwell.

Puputti, A. K. (2008). A zooarchaeology of modernizing human-animal relationships in Tornio, Northern Finland 1620–1800. *Post-Medieval Archaeology, 42*(2), 304–316.

Puputti, A. K. (2010). *Living with Animals: A Zooarchaeological Study of Urban Human-animal Relationships in Early Modern Tornio, 1621–1800,* Volume 2100 BAR International Series, British Archaeological Reports, Oxford, Archaeopress.

Reinhard, K. J. (1992). Parasitology as an interpretive tool in archaeology. *American Antiquity, 57*, 231–245.

Reinhard, K. J. (1994). Sanitation and parasitism at harpers ferry, West Virginia. *Historical Archaeology, 28*(4), 62–67.

Reinhard, K. J., Mrozowski, S. A., & Orloski, K. A. (1986). Privies, pollen, parasites, and seeds, a biological nexus in historic archaeology. *Masca Journal, 4*(1), 31–36.

Sassaman, K. E. (2010). *The Eastern Archaic, Historicized*. Latham: AltaMira.

Sassaman, K. E. (2012). Futurologists look back. *Archaeologies: Journal of World The Archaeological Congress, 8*, 250–268.

Schávelzon, D. (2005). When the revolution reached the countryside: Use and destruction of imported wares in Alta Gracia, Córdoba, 1810. *International Journal of Historical Archaeology, 9*, 195–207.

Schmidt, P. R., & Mrozowski, S. A. (Eds.). (2013). *The death of prehistory*. Oxford: Oxford University Press.

Schroeder, R. A., Martin, K. S., & Albert, K. E. (2006). Political ecology in North America: Discovering the Third World within? *Geoforum, 37*, 163–168.

Shackel, P. A. (1993). *Personal discipline and material culture: An archaeology of Annapolis*. Knoxville: University of Tennessee Press.

Sweet, E., Nandi, A., Adam, E., & McDade, T. W. (2013). The high price of debt: Household financial debt and its impact on mental and physical health. *Social Science and Medicine, 91*, 94–100.
Symonds, J. (2013). Colonial Encounters of the Nordic Kind. In N. Naum & J. M. Nordin (Eds.), *Scandinavian colonialism and the rise of modernity: Small time agents in a global arena* (pp. 307–319). New York: Springer.
Taylor, E. L. (1955). Parasitic helminthes in medieval remains. *Veterinary Record, 67*, 216–218.
Trigg, H., & Jacobucci, S. (2008). Urbanization and human parasites: Implications for health in urban communities. Poster presented at the 73rd Meeting of the Society for American Archaeology, 26–30th March 2008, Vancouver.
Trigg, H. B., Jacobucci, S. A., Mrozowski, S. A., & Steinberg, J. (2017). Archaeological parasites as indicators of environmental change in urbanizing landscapes: Implications for health and social status. *American Antiquity, 82*(3), 517–535.
Uggla, Y. (2010). What is this thing called 'Natural'? The nature-culture divide in climate change and biodiversity policy. *Journal of Political Ecology, 17*, 79–91.
Underwood, E. (2014). Can disparities be deadly? Controversial research explores whether living in unequal society can make people sick. *Science, 344*(6186), 829–831.
Voss, B. L. (2012). Status and ceramics in Spanish colonial archaeology. *Historical Archaeology, 46*(2), 39–54.
Walker, J. H. (2012). Recent landscape archaeology in South America. *Journal of Archaeological Research, 20*(4), 309–355.
Wallerstein, I. (1974). *The modern world system I: Capitalist agriculture and the origins of the European world-economy in the sixteenth century*. New York: Academic Press.
Wallerstein, I. (1980). *The modern world system II: Mercantilism and the consolidation of the European world-economy, 1600–1750*. New York: Academic Press.
Wallerstein, I. (1991). Braudel on capitalism, or everything upside down. *The Journal of Modern History, 63*(2), 354–361.
Wilkie, L. A., & Farnsworth, P. (1999). Trade and the construction of Bahamian identity: A multiscalar exploration. *International Journal of Historical Archaeology, 3*(4), 283–320.
Wolfe, C. (2010). *What is Posthumanism?* Minneapolis: University of Minnesota Press.
Wurst, L. A. (1999). Internalizing class in historical archaeology. *Historical Archaeology, 33*(1), 7–21.
Wurst, L. A. (2015). The historical archaeology of capitalist dispossession. *Capital And Class, 39*(1), 33–49.
Wurst, L. A., & Mrozowski, S. A. (2014). Toward an archaeology of the future. *International Journal of Historical Archaeology, 18*(2), 210–223.
Zarankin, A. Y., & Senatore, M. X. (2005). Archaeology in Antarctica: Nineteenth century capitalism expansion strategies. *International Journal of Historical Archaeology, 9*(1), 43–56.

Part II
Studies on Environmental Historical Archaeology

Chapter 4
Eco-historical Archaeology in the Brazilian Amazon: Material, Natural and Cultural Western Transformations

Diogo M. Costa

Abstract This chapter presents historical facts on the Western presence in the Amazon and discusses the environmental impacts generated by this presence and its probable material, natural and cultural legacy. What has led modern Western society to try to transform the Amazon forest over the last 500 years? To answer this question, I will investigate when, where and how these changes occurred in the Amazon environment and discuss the significance of the eco-historical archaeological remains. I will also discuss why these transformations occurred and examine the populations they affected during the history of the Western colonization of the Amazon.

4.1 Introduction

The Amazon—the "green desert"—is an immense area that comprises more than 60% of Brazil's national territory. However, note that since colonial times, the discourse of idleness in the Amazon has been the principal rationale for justifying the systematic transformations performed by Western society beginning with its first period of occupation. This rationale was based initially on the widespread idea of demographic emptiness in the Amazon, because the native populations living there never served the developmental model pursued by the European colonizers.

Following the line of reasoning that existed in colonial times, the "scientific" discourse around the land's emptiness also created a narrative in which the soil's poverty was responsible for the lack of agriculture and that the unhealthiness of climate was responsible for the indigenous people's apathy. Today, in contrast to the common perception of emptiness and idleness that had been in vogue for centuries, an increasing understanding has grown of the long-term existence in the region of a particular human historical symbiosis with the environment and a unique geographic

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interaction of the water, forest and animals. However, this non-Western point of view about a world of relationships between humans and nonhumans was not widely held during the colonial occupation.

However, the occupation did not proceed according to the Western European model, other than during the process of internalization in the imperial period, for a number of reasons. First, human occupation in the Amazon primarily followed the routes of the rivers to disperse the population along its course. Water in the Amazon is not only a divider of worlds but also their connection; these river paths have connected human-occupied areas since precolonial times. With the arrival of Europeans in the area, the paths became one of the main points of conflict between the colonizing powers. What isolates also unites, not only distant points on the horizon but also the tides, whose ebb and flow led to the accumulation of beings and things floating through the domains of water spirits.

Water was also a common resource used by the colonizers in the first period of the Amazon occupation; they implanted a tide technology system imported from the Europe to power sugar mills on the Amazon River. The tide-powered mills were the first stage of a strategy to occupy the area. In the beginning of the colonial process, many European powers also wanted to install in the Amazon the agro-exporting sugar profit model used in the Brazilian northeast. As builders of this type of colonial enterprise in the Amazon I can cite the Dutch, British and Portuguese, the last of whom effectively pursued this endeavor for a long time. Today these mills are vivid archaeological remains of eco-historical Western transformations in the area.

Second, the vegetation cover—which has always been a barrier to Western development projects but was also the colonizers' primary supplier of resources—requires replenishing. The forest's main natural resource is wood, which has been marketed since the early days of European colonization; colonists chose the best logs to export to Europe, including cedar, *piquiá*, *pau-santo*, *pau d'arco*, *ipê*, *jenipapo* and other species. Used for everything from shipbuilding to large-scale construction projects, Amazonian woods were used to create palaces, churches, monasteries and convents throughout post-medieval Europe. The forest is also home to exotic leaves and fruits such as the pineapple, which with its crown of thorns and designation by the Portuguese as the "king of fruits" enchanted the greatest colonial potentates such as the governor according to various foreign chroniclers.

Conversely, the same forest was the nursery for several plant species introduced by the Europeans in the region, such as the mango, brought from Cayenne, which later became the symbolic tree of Belém city in today's Pará state. One of these environmental impacts is that a botanical garden was created in 1791 to receive the plants.[1] Located on the old road of São José, the garden was run by a Frenchman named M. Grenoullier and cultivated 2382 plants, including 82 species from Pará, other Brazilian provinces and Cayenne. Among the plants cultivated by the

[1] The first historical note about a Botanical Garden in Belém was on September 4, 1789, when a royal letter gave final shape to the project (Cruz 1973, p. 136).

Europeans in the colonial Amazon were the apricot trees of S. Domingos Island, the guavas of Mato Grosso province, the jackdaws of Bahia province, the passion fruit of Cayenne and the sapodilla of Mexico. In addition to this garden, another was located near the flooded Piri Lake created in 1809 at the initiative of the Count of Arches. The first was called *Caneleiras* Garden and the second simply the Botanical Garden; both disappeared from the city after 1830. Belém's Botanical Garden also became the main recipient of the products brought after the invasion of Cayenne by the Portuguese in 1808,[2] including clove, nutmeg, pepper, cinnamon and sugar cane.

Third, animals were another primordial resource extracted from the Amazon in the early colonization period. Among the most exploited animals was the turtle,[3] a source of food eaten (in the form of its meat, eggs and butter) by early travelers such as Alexandre Rodrigues Ferreira in 1784. Tortoise butter was actually a sought-after product, particularly during the months of November and December when the animals crowded the beaches on the rivers. Its grease was often used for lighting in both public and private lamps. Considered by the Portuguese the "cow of the Amazon," there were immense corrals for its husbandry in which were registered 2896 animals in the Negro River alone in 1785. Another food that was very sought after was fish, particularly the *pirarucu* and the manatee— an herbivorous marine mammal; the first considered the "cod of the State," whereas the second was called the "tuna of the Kingdom."

In addition to alimentation, exoticism also fueled Europeans' desire for the Amazonian fauna. Portuguese noblemen made several requests to the colonizers for the importation of birds, particularly birds with colorful plumage; the living would stay in the gardens and the embalmed ones in the collections. The order lists included yellow, blue and green parakeets; mutts; macaws, *urubutingas*; and *tuiuiús*. In addition to the birds, *mucuras*, deer, coatis, monkeys and jaguars were exported. However, it is not my intent here to assume a position on environmental policy, whether conservationist or preservationist,[4] but rather to perceive the eco-historical influence of Western society in the Amazon environment, and vice versa. To this end, I will now conduct a historical and geographical retrospective of Western post-contact effects on the Amazonian environment and the legacy left through the materiality created by these societies (Fig. 4.1).[5]

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[2] The transplantation of foreign species to Cayenne was the patient and delicate work of the French government, which contracted experienced gardeners and agriculture technicians in France to plant those species in Guyana (Cruz 1973, p. 138).

[3] The Portuguese colonial authorities forced the indigenous people to travel up the Amazon and Solimões Rivers each year from October until December to harvest the turtles (Tocantins 1960, p. 115).

[4] In a conservationist approach, nature is a resource that can be used in a sustainable form; in a preservationist approach, nature is pristine and must not be touched or changed (Carter 2007).

[5] Other than one innovative approach, few works have been recently examined eco-historical archaeology in Brazil (D. M. Costa 2010, 2011a, b, 2012, 2013, 2014, 2015).

Fig. 4.1 Pineapple plantation combining pre-colonial and modern techniques in an Amazonian earthwork circle form, Mapuá River in the Marajó Islands, Amazon. (Costa 2015)

4.2 Material and Historical Western Transformations in the Amazon

In the last 500 years, the Amazonian forest has been transformed materially and historically by Western society. Although the Portuguese eventually became dominant, the first Europeans to look on the green sea were not Portuguese[6] but rather Spanish, British, Dutch and French.

Despite some unsuccessful forays, such as those of Pison and Lepe in the fifteenth century, the Spaniards were the first Europeans to tread in the Amazon, although only in the sixteenth century did an effective Spanish expedition traverse the entire Amazon River. The expedition was initiated by Pizarro but completed by Orellana and was followed by Ursua and Aguirre. However, Spain was more concerned with preventing access to its valuable Potosi mines, and the Spanish occupation of the region was never a priority.[7] The environmental impacts of these expeditions were small, and the material legacy of these enterprises probably ephemeral.

[6] Despite controversies, the report of the Portuguese Duarte Pacheco Pereira on his navigation between the coast of Maranhão and Pará at the end of 1498 cannot be ignored (Esmeraldo de Situ Orbis, in: http://www2.senado.leg.br/bdsf/item/id/242845 accessed in 08/13/2016).

[7] The landings were almost certainly for imprisonment of indigenous people and to collect food, temporary encampments or even to bury the dead killed in combat or by starvation, disease or civil unrest (Bentes 2007, pp. 7–30; Gadelha 2002, pp. 75–77).

Other Europeans[8] present in this period included the British,[9] in the mid-sixteenth century, who were already raiding the coast of the Guianas and in 1611 and establishing a trading post in the Amazon delta. The main English presence in the Amazon was the Camaú or Cumaú fort in the North Cape and later Amapá; and the Irish had the fort of Torego or Torrejo in the island of the Tucujus, later called Fort Felipe when it was taken over by the Portuguese. It stood on the banks of Oiapoque River, occupying the left margin of the river and included a trading post in the Araguari River. These effective first contacts possibly left a material legacy that in some cases can be traced back through historical archaeological work.

The Dutch in their strongholds and wood mills such as in Gurupá and Xingu[10] had already been exploiting and exporting products of the earth, such as manatee oil, from at least the late-sixteenth century. In the exchange of products with the natives, social relations increased and, eventually, an interest in gold developed that also later attracted Portuguese eyes to the region. The first Dutch sugar mills were on the Xingu River, one named Muturu and the other Curianiná, and were defended by Fort Orange and Nassau, respectively. In addition to sugar, the Dutch traded tobacco produced in the Amazon and brought the first African slaves to the region.[11]

The presence of the French in the Amazon dates back to 1583, when they began to trade with the Indians. The French also tried to settle in the region of the North Cape today called Amapá; in 1605, they began the occupation of Guiana. From there, they tried to attain hegemony. During the seventeenth century, they attempted to found several fortifications and colonies. This resulted in a conflict that continued until the first years of the republic, when the question was solved only after armed combat in the region. In 1613, the Frenchman Daniel de La Touche, starting from Maranhão, arrived at the Tupinambás Indians' port on the Guamá River, where would be later created the city of Belém. He then left for the Tocantins River, where he also took possession of the lands that later hosted the captaincy of Cametá.[12] With their strong intention to occupy the North Cape, the French influence in the Amazon would continue to be felt for centuries.

After the expulsion of the French in 1614 in São Luiz do Maranhão, the Portuguese designated Francisco Caldeira Castelo Branco to take possession of the land in the Amazon, beginning with founding the city of Our Lady of Grand Belém

[8] In other countries, Dutch and British companies rather than the state began the colonization of the Amazon (Filho et al. 2001, p. 16).

[9] Since the British exploratory voyages in the last decade of the sixteenth century on the Amazon coast (Hulsman 2011, p. 181).

[10] On the right bank of the Amazon, the Dutch had the strongholds of Maturu, Samú, Mandiutuba and Mariocai; on the ruins of these, the Portuguese later erected the fort of St. Anthony of Gurupá. In the Northern Cape, the Dutch built a fortified position between the Maicaré and Cassiporé rivers (Cruz 1973, p. 48).

[11] Slaves were also present in the regions of the Tapajós River and north of the Amazon river (Guzmán and Hulsman 2016, pp. 19–24).

[12] Seeking to implement plans to extend the French dominions in the lands 'bathed by the Paranáassu', as the natives call the Amazon River, the Lord of La Ravardière undertook the trip to Tocantins (Cruz 1973, p. 24).

of Pará in 1616.[13] In 1751, another 96 adventurers completed the occupation forces, which now included numerous volunteers and prisoners. As the first Portuguese city in the Amazon, Belém would be the major point of access to the immense equatorial forest until the end of the nineteenth and the beginning of the twentieth century. With its central location, the city supported all of the expansion efforts of the Portuguese in the area. In this period, the Portuguese were linked to Spain by the Iberian Union (1580–1640) and tried to deploy the captaincies system in the Amazon beginning in 1627.[14] However, the majority of the enterprises were failures except for Camutá, whose owner in 1635 founded Vila Visçosa de Santa Cruz do Camutá, later known as the city of Cametá, in a location already populated by a mission of the established Camutá Indians in 1620 and influenced by the work of Frei Cristovão de São José, who had arrived there in 1617.

These urban nuclei were mostly established initially with settlers, many of them from the Azorean archipelago, and then filled with prisoners of the metropolis, who saw in the colonizing work a way to expunge their crimes. Other attempts at colonization by the Portuguese government would also occur, such as the fixation of Swiss in the Villa Vistosa of Our Lady of Madre de Deus on the Anarapucu River between 1766 and 1772 and, in the same period, the best-known attempt of the Mazagão African colonizers in 1769. Following the Freyran paradigm of miscegenation, the strategy of the Portuguese was always the internalization of the autochthonous societies that shared their colonial endeavors and subjugation of those that did not. However, the homogenization of some places in the Amazon was less an intention than a consequence of Portuguese presence in the territory.

The environmental impact of these actions is today perpetuated in a material legacy that persists in the occupied regions of the Amazon. Over the half of a millenium, the Amazonian forest has been transformed in several areas materially and historically by the actions of Western society. As a prime example of these events, I will explore the colonizers' efforts at urbanization. Forts and missions were the first priorities of the Portuguese kingdom in the tropical lands, in order to facilitate clearing and exploitation. These outposts provide the first clusters of the colonizers' environmental impact on their surroundings.

As an attempt to prevent the advance of other Europeans in the Amazon, the Portuguese began to erect a series of forts in the region in the seventeenth century. These included the Nativity fort in 1616, the fort of Gurupá in 1633, São Pedro Nolasco Fort in 1665 (that no longer exists[15]), the fort of São José do Rio Negro in 1669, the fort of Parus in 1685, the fort of Macapá in 1688 and the forts of Santarém (previously called Tapajós) and Óbidos (formerly called Pauxis) in 1697. The fort of

[13] However, only in 1676 did 50 families coming from the Azores to work in agriculture disembark in Belém (Cruz 1973, p. 63).

[14] The Amazonian captaincies were at the time Caeté, Camutá, North Cape, Marajó, Xingu and Gurupá (Tocantins 1960, p. 40).

[15] Of great importance in colonial Pará was the strength of Our Lady of Mercy of the bar, which was destroyed by an explosion. The fort exchanged fire with a small fort opposite to it and with the battery on the island of parakeets located down the river (Cruz 1973, p. 49).

Desterro in Amapá was destroyed in 1697 by the Governor of Cayenne, and another was built at the mouth of the Toeré River with the same name. In addition to this line of defense, in the eighteenth century, we also have the forts of São Gabriel da Cachoeira and São José do Marabitanas in 1761, Fort São Joaquim in 1775, Fort São Francisco Xavier de Tabatinga in 1776 and Fort Principe of Beira in 1785. The environmental impacts of these first occupations were the large-scale land transformation where the forts were built and the political, social and economic effects on the surrounding population.

However, previous to the actions of the Portuguese royalty, religious orders had already established themselves in several areas of the Amazon. The first to arrive were the Capuchins of Saint Anthony in 1617, then the Carmelites and Mercedarians in 1626 and 1627 and finally the Jesuits in 1636. The missions were self-sustaining undertakings involving the production of cotton, flour, sugar and spirits; cattle breeding; fish and the commercialization of spices.[16] In addition to building its convent in Belém in 1626, the order of the Capuchins of Saint Anthony founded two centers of catechesis in Almerim and another in Chaves in 1757 and 1758. The order of the Capuchins of St. Joseph also arrived in 1639 in the previously Dutch-occupied village of Maturu, today called the Port of Moz. The Capuchins da Piedade, who also arrived in Gurupá, built a hospice there in 1639 and then founded several villages: Surubiu, known today as Alenquer; Jumundás, today Faro; Guarupatiba, today Monte Alegre; Pauxís, today Óbidos; Outeiro, today Prainha; and the village of Jurití.

The Mercedarians erected their convent in 1640 and founded the village of Mangabeira in the Marajó-assu, today, Ponta de Pedras. The Carmelites built their first convent in 1626, replaced it with another in 1696 and finally built a final one in 1708; in 1645 they founded a convent in Gurupá, and in 1733 a church in Vigia. The Jesuits, although only settling in the region in 1653, inaugurated their college in 1668, followed by one in Marajó where they raised cattle. In 1731, they constructed another college in Vigia, but their conflict with the settlers concerning the indigenous slaves continued until the Jesuits' expulsion in 1757, which was followed in later years by expulsions of the other orders.

Until 1755, 63 missionary villages concentrated more than 50,000 indigenous people. The villages were divided between six different orders, 26 under the administration of the Jesuit priests and another 26 under the administration of the Capuchin priests.[17] The environmental impacts of these establishments were enormous, from the importing of new plants and animals to the exporting of native fauna and flora. The commercial aspects of the missions were unparalleled; in a pre-industrial world, their internal organization and external actions were quite similar to those of a modern enterprise. From the embryo of the missionary villages—replete with

[16] As cocoa, cloves, vanilla, and cinnamon (Costa and Arenz 2015, p. 94).

[17] The Charter of 1693 established influence zones for the religious orders: the Jesuits were on the southern bank of the Amazon, the Capuchin friars of St. Anthony in the Cape North and the northern bank of the sea and Da Piedade priests in the Gurupá district (Tocantins 1960, p. 45).

batteries of cannon and pillories in their central squares as a mark of the secularization of the villages—came many of the current municipalities in the Amazon today.

Belém was the first Portuguese city in the Amazon, founded in 1616 as a bulwark to repel the British, Dutch and French who tried to occupy the Amazon trading posts. Disembarking at the highest part of the terrain, the Portuguese Castelo Branco soon began the construction of a fort called Nativity and a chapel for NS of Grace, naming the place Happy Lusitania and placing it under the protection of NS of Belém. However, possibly due to environmental factors, the Portuguese tried to change the location many times, all without success. The first attempt was in 1619, to Honey's Point, today, Pinheiro; the second, in 1633, was to Sun Island, today, Colares; and the last in 1655 was to the village of Aruans[18] on Joanes Island rather than the town of Joanes.

In the seventeenth century,[19] religious buildings spread over the landscape of Belém, including the Una Hospice established by the Capuchins in 1617, the Carmo Convent in 1626 erected by the Carmelites and the Convent of Mercy in 1640 created by Mercedarians. In 1653, the year of the arrival of the Jesuits, the construction of the House of Customs also occurred, and the Jesuits settled in 1668 in the College and Church of Saint Alexander. In the first quarter of the eighteenth century, the House of Residence for the governors was in Belém. It was rebuilt in 1762 by Antonio Landi, and the Council Pairs were where the Senate and the House functioned. At this time, the city was divided into two districts, the Old City and Campina. The unsanitary houses had walls of mud and pestle, roofs had straw rather than tiles and the windows were shuttered with fabric.

On the surrounding roads and on the banks of the Guamá River, cocoa, vanilla, cloves, cinnamon, sugar and cotton were planted. The surplus was sold by royal order until 1864. In the mid-nineteenth century, the city of Belém of Pará represented to European travelers "sad" buildings, "indolent" people and "cobbled" streets. In 1902, at the height of the rubber industry, the city had more than 150,000 inhabitants; the streets were more than 40 meters wide and were surrounded by mango trees and square gardens in the European style.[20] Conversely, Manaus was founded in 1657 but only became capital of the province of Amazonas in 1850. As a bastion for the occupation of the Amazon, it became the El Dorado of rubber, or black gold. In 1865, Manaus was, in the view of travelers, only a cluster of houses, with rickety buildings decorated with official names. With the rise of rubber indus-

[18] This village was home to the Sacacas people under the invocation of Our Lady of the Rosary and their location in the desolate and parceled coast could not be proposed as the seat of the city (Barata 1973, pp. 210–211).

[19] In the year 1650 the population of Belém counted of 80 souls, excluding the natives, soldiers and members of religious orders (Cruz 1973, p. 34).

[20] The city did not expand to the west toward the Amazon rainforest but instead retreated to its eastern border toward the sea, a movement that the Bragança railroad would later solidify (Carneiro 1980, p. 182).

Fig. 4.2 *Baladeira*, an artisan weapon combining a shotgun and a bow to shoot bullets, most likely of the beginning of XX century, Mapuá River in the Marajó Islands—Amazon. (Costa 2015)

try at the beginning of the twentieth century, Manaus reached a population of 50,000 inhabitants and had lined and spacious streets.

The urban environments in the Amazon are without exception a clear example of long-duration human transformations of the landscape. The effects of social activity in the natural space have been manifested since the first occupations in many areas. Similar to the examples of Belém and Manaus, many other cities in the Amazon were built on locations of forts and missions that in turn had been constructed on or around indigenous settlements. Conversely, there are the riverside peoples in the Amazon on the margin of these urban grids today that keep pre-colonial traditions amalgamated with modern ways of live (Fig. 4.2).

4.3 Natural and Environmental Western Transformations in the Amazon

Western society has been naturally and environmentally transforming the Amazonian forest in the last 500 years primarily in two ways—initially as a commercial source of ready-made products and then as a source of raw material for manufactured products. These practices began with the establishment of the first European settlements on Amazonian soil and have continued into modern times throughout the region.

Drugs and other products were extracted from many of the resources of the forest: aromatic and palatable seeds and roots, medicinal plants, dyes, resins, vegetable and animal oils, plumage, hides and skins. However, even in the colonial period, harvesting outside the permitted period was subject to up to two months in jail and a fine of 20,000 thousand *Réis*.[21] Spices such as cloves, cinnamon and nutmeg were already well known to Europeans from the East, where through their Arab heritage the Portuguese knew how to maintain commercial control. In Brazil, cinnamon was found in a natural state in the Amazon, but was of inferior quality to Indian cinnamon. Therefore, the seedlings planted in the Grão-Pará Captaincy were brought by the priests of Bahia, where cinnamon had also been used as a stimulant and tonic since 1731.[22] Clove and nutmeg were smuggled from Cayenne despite the watchfulness of the French and were used as a treatment for headache, while the native vanilla of Mexico was one of the first spices from the New World to please the European palate.

The universe of medicinal plants was also immense. Among others, I can mention the *quina,* which was used against fever; the *guaraná*, which was first used to treat diarrhea, headaches and kidney ailments and as an aphrodisiac; sarsaparilla, against syphilis and rheumatism; and sassafras, which also occurs in all Brazil, against the *dartos.* The *canafistula* was used for purges; aromatic precious bark was also used for poor digestion, antispasmodics and bronchitis. The cask of the cashew tree was used for *iciterícia*; gentian root is good for the stomach and improves menstrual flow. The root of *manacá* is used against venereal diseases; the root of *tajamembeca* for problems in the lungs; and *Curupira* milk for chest pains and fractures. *Puxuri* Jerk seasoning, besides pleasing noses, was also used for vomiting and diarrhea; and *Urucu*, in addition to being used in the kitchen for the coloring of foods, has a digestive root and expectorant seeds. Other items include the olives of *copaiba* and *merium* and the turtle and tortoise butters added to the apothecary and diet of the colonizers.

Exported to Europe, these leaves, barks, roots and seeds were supplied in their natural state to hospitals and family homes and in a type of medicinal infusion today called "*garrafada*" in the north. The environmental impact of these extractions beginning in the colonial period was not large; because the plants occur in natural form, the time and place of harvesting were dictated by the forest. Conversely, the socio-political and economic effects on the native peoples were enormous, causing a complete restructuring of the pre-colonial contacted society.

Before the arrival of the Portuguese in Grão-Pará Captaincy, sugar[23] mills were already being implanted by the Dutch in Xingú and by the English in Amapá. Coming from the northeast, the Portuguese[24] therefore had a double mission—to expel the French from St. Louis and the English and Dutch from the Amazon, and to build sugar mills and cultivate cane fields, following a northeastern model for the

[21] *Réis* are the plural of *Real*, a Portuguese currency (1430-1911) valid in Brazil from the sixteenth century until 1942, in 1860 approximately 100 Réis was equivalent to one gram of gold.

[22] In 1804, a total of 972 feet of cinnamon trees annually produced 200 kilos in Belém (Barata 1973, p. 318).

[23] Sugarcane originally came from India, where it is known as "red honey" and has been purified in mills since 300 B.C. It was initially used as a medicinal compound when it reached England in 1319 and was first brought to the New World by the Spanish to explore the possibility of production. However, only after1650 did it become economically dominant (McKenna 1992, p. 96).

[24] The sugar cane brought to Brazil by the Portuguese came from the Maderia islands, a Mediterranean variety cultivated in Sicily since the fifteenth century (Carita 2013, p. 162).

region.[25] However, sugar cane was already known to the natives and was offered as a gift to both Pedro Teixeira and his men during their Belem travel to Quito from 1637 to 1639.[26] The first Portuguese sugar producer in the Grão-Pará Captaincy was the very same Francisco Caldeira de Castelo Branco who also founded Fort Nativity between 1616 and 1618. He was followed by Feliciano Coelho, who set up a sugar mill in his captaincy of Camutá in 1634 (confirmed by a royal order in 1667, the same year that the crown authorized the entry of seedlings of the island of Madeira). The religious orders also built their mills, the most famous of which were the Carmelites priests' Santa Teresa de Monte Alegre mill on the left bank of the Bujaru River in 1627 and the Jesuit priests' Jaguarari mill on the Moju River in 1669.

In 1751, there were already 24 sugar mills in Pará[27]; among the most prominent were the mills of Murutucu,[28] Jaguarari, Cafezal, Monte Alegre and Palheta.[29] Beginning in 1723, the amount of land used for sugar mills in the region of the Guamá River was significant; this was later followed development along rivers Capim, Gurupá, Arari and Anajás, among others. In Belém, the mills were concentrated in the strip from Travessa São Matheus, a border of Campina with the Old City, to the convent of São Boventura, today the Arsenal of the Navy. In 1740, sugar was common currency in the province, as were cloves, cacao and cotton balls, which were worth 3000 *Réis* per arroba. However, as early as 1761, a royal order highlighted the poor quality of sugar, despite its being harvested for 30 years. In 1797, the introduction of the best-quality cane of Cayenne began.

Sugar production has always been in the background in Grão-Pará Captaincy, with priority given to spirits. In 1751, a total of 77 small mills already existed for the manufacture of sugar spirit along with the 24 sugar mills on the sugar plantations, which, despite the royal order of 1706 that prohibited the manufacture of sugar spirits, made this beverage the main export product for Africa, the Azores, Portugal and then Brazil. As a measure of this traffic, the export of barrels of spirits, grew continuously: 788 barrels in 1816, then 962 in 1817 and more than a century later (from 1948 to 1952) exports of spirits from the Amazon reached ten times that of sugar.

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[25] To the Portuguese, the goal of the Amazon conquest was the foundation of the sugar industry in Pará (Tocantins 1960, p. 60).

[26] Sugar cane in the Amazon had been known to the British and Dutch at least since 1598, according to Jan de Laet in his *History of Noco World* [1633–1640] (Barata 1973, p. 314).

[27] Among the most important mills, we have Valde Caens in Guajará Bay; S. Matheus on the Barcarena River; Mucajuba, Guaramucú, Garden, and NS Estrella of the Monte Libano or Pernambuco, on the Guajará, aka Guamá River; Guajarámiri on the river of the same name; Utinga and Murutucú on the streams of the same names; Itacuan, Ibirajuba or Barajuba, Carambaba, Jaguarari, Itaboca and Juquiri on the Moju River; Taperuçu and Apuruaga on the Capim River; Tauaú and Itapicuru on the Acará River; Marapatá in the eponymous bay; Curuçambaba on the Tocantins River; and Marauaú in the Canaticu River (Barata 1973, pp. 316–318).

[28] The Murutucu sugar cane mill extended from the Tucunduba stream to the Uriboca stream in the lands of Utinga farm. The farm belonged to the militia lieutenant colonel João Antonio Rodrigues Martins. The Murutucu chapel was built in 1711 and restored by the architect José Landi in 1762; it was dedicated to Our Lady of Conception (Cruz 1973, p. 65).

[29] In the municipalities of Iguarapé-Miri and Abaetetuba alone there were approximately 72 mills operating from the seventeenth to twentieth centuries (Garcia and Lobato 2011).

Tobacco[30] and sugar cane were also found in their native forms in the Amazon and were additional export products of the Grão-Pará Captaincy in colonial times, so much so that in 1754, its farmers demonstrated against the inspection of production and the appointment of only mill owners for the inspection of the province. The environmental impacts of tobacco and the sugar colonial plantations in the Amazon were not measured, but the legacy of these effects were probably more local than widespread. Conversely, the structures of the mills are the material markers of these enterprises and the archaeological study of these vestiges enhance our understanding of the inhabitants' everyday practices.[31]

However, no American product has affected Europe since the arrival of the colonizers in the Amazon as much as cocoa.[32] Used as currency since the pre-colonial period, cocoa took over the financial market until at least 1750 in the Amazon, when by royal order the use of metallic coins in the exchange of products was introduced, with severe penalties for those who disfigured or used the metal for other purposes. The first seeds from the Amazon were those that germinated the cocoa industry in Bahia in 1655,[33] whereas the chocolate created in Grão-Pará in 1687 by a Frenchman was traded directly with Europe. The Amazonian cocoa industry decline occurred only in the middle of the nineteenth century, when the great plantations in Bahia appeared.

Cocoa was originally harvested in the woods and was called wild cocoa; its first cultivation was achieved in 1678 after a royal order of the king promulgated in 1677. Thereafter, it began to be called meek cacao. In 1680, the court imposed a planting tax on cacao for six years and on vanilla and indigo for four. In 1730, there were already 1.5 million feet in Grão-Pará. However, in 1749, this number had already decreased to 700,000. In 1750, the export of cacao to Portugal reached the a total of 64,427 arrobas (the arroba is approximately equal to 15 kg). Cocoa was the first export product that was cultivated in the Amazon forest, with plantations in the Tocantins e Tapajós areas that employed slaves, initially culled from the indigenous people and later imported from Africa.

[30] First experienced by Columbus' crew, who "drank the smoke", tobacco has been used in Mayan rituals since 600–800 B.C. In Europe, it was first used for recreational and medicinal purpose, as a purge and aphrodisiac. However, in 1648, it acquired its highest economic status in the North American colonies and become their main export (McKenna 1992, pp. 108–109).

[31] Many studies are being conducted today about the material culture of these sites in the PPGA/UFPA, such as ethnicity studies about daily pottery and smoking pipes, technological studies about glass tools and gun flints, economic and gender studies about ceramic and metal remains, ideological and practical uses of the buildings structures, and the public interpretation of the archaeological finds.

[32] Serving a sacramental role in Mayan and Aztec civilizations, the cocoa beans were mixed with mushrooms and drunk in ceremonial feasts, brought to Spain in the beginning of the sixteenth century and only later appeared in Italy in 1606 and in France and England in 1650 when they became the favorite vehicle for poisoning (McKenna 1992, p. 103).

[33] In the Amazon, the large cacao plantations were in the Villa Franca and in the lower Tocantins property of Moraes Bittencourt, the Carapajó lords (Barata 1973, p. 308).

Initially collected in its original form in the forest, so-called red rice was replaced in 1772 by white rice,[34] brought from Carolina/EUA by the Trade Company of Grão-Pará and Maranhão. White rice formed a monoculture export to Portugal and was planted in the surroundings of Belém in the late nineteenth century, when it already had undergone beneficiation in plants such as the North American Upton mill in the Maguari stream in the Marajó islands or the Arrozoal stream in Barcarena. The first export of the Amazonian exportation occurred in 1773,[35] when Lieutenant Colonel Theodosius Constantine Chermont, a rice farmer, sent 30 sacks to Lisbon from his own mill.

Meanwhile, the first coffee[36] seedlings were brought to the Amazon by the Dutch, who planted their colony in Suriname in 1720. Meanwhile the French in 1723 smuggled some seedlings to Cayenne. In turn, Francisco Xavier Botero transported some seedlings and seeds in 1724 from Cayenne to Belém, where in 1731 several plantations were already generating a surplus. Among the first coffee growers was Agostinho Domingos de Sequeira, with farms in Guamá; his first export of seven pounds occurs in 1732 in the boat Santa Maria. According to some historians, the product would later have been taken to Maranhão and other captaincies until it reached the Paraíba Valley, where he founded a gigantic coffee industry. Coffee production for export ended in the Amazon in 1870.

Cotton[37] was also produced during the process of colonization of the Amazon for both export and consumption. Growing spontaneously, its manufacture in skeins was even used as currency according to weight in 1749. At a certain point, it became the number one product of the colony, used to make clothes, hammocks and candles. The first seeds were brought to the Amazon by the Frenchman Albanel La Sablier from Cayenne, who also introduced modern ginning techniques.[38] During the late eighteenth and early nineteenth centuries, the great export products of Amazon were cacao, rice, coffee and cotton. Originally, many of these products had only Portugal as a destination. However, with the opening of the ports after 1808, trading also began with other international markets and even other provinces in Brazil.[39]

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[34] Since the Vedic times 1200 to 900 B.C, the Aryans planted rice in the Indus Valley but in less proportion than wheat, which had its apogee between 750 and 1200 A.D. (Lindebaum 1987, p. 428).

[35] Between the years of 1773 and 1800, rice was exported to Portugal—2055 kilos of the product (Tocantins 1960, p. 181).

[36] Originally from Ethiopia and Arabia, coffe was introduced in Europe as food and medicine mixed with wine. Only in 1100 did it become a drink, and only in the thirteenth century was it roasted (for the first time in Syria) (McKenna 1992).

[37] Cotton was also found in its native form in the Amazon (Cardoso 2015, p. 7).

[38] From the colonial period on, every house in the Amazon had a gin, spinning wheel and loom (Tocantins 1960, p. 98)

[39] During the period; the Amazon also exported sugar; brandy; fine and coarse cloves; cinnamon; sarsaparilla; *puchiri*; logs and planks of various woods; hides dried, salted and tanned; indigo; copal and *andiroba* oils; annatto; cotton yarn; *samaúma*; honey; tapioca; chestnut; *cebo* bread; *guaraná*; turtle butter; soap; gum copal; rosin; and chocolate (Barata 1973, p. 307).

The first cattle arrived in Belém in 1644; coming from the Cape Verde Islands, the oxen and cows were destined for the backyards of houses, farms and nearby estates. In the Marajó Islands, the first farms begin to appear in 1680 in the eastern and central part, such as the Amanigetuba farm of Francisco Rodrigues Pereira in the Arari River; and only after 1757 were cattle introduced at other farms on the west coast, where they eventually numbered more than 400,000 head.[40] In 1726, the first butcher's shop was created in Belém in a single-story house with three doors and its back to the beach, where the cattle from the Arari River farms were disembarked. In 1781, it was transferred to the left bank of the Bay of St. Joseph, in 1840 to the Holy Spirit Street, in 1864 to the slaughterhouse platter and finally in 1912 to the left bank of the Maguari River.[41] Thus, in 1885, the livestock industry of the Marajó Islands was in a state of decline, as were agricultural industries such as the sugar mills; rice, maize and cassava plantations; and butter and cheese factories.

However, no product had as intense an effect inside and outside the Amazon as did rubber. Even in Christopher Columbus' first voyages, the strange balls made of latex from the rubber tree impressed the Europeans. After numerous raids throughout the Amazon to grasp the process of extracting the sap, in 1736, the French astronomer Charles Marie de La Condamine not only learned the process but also adopted it for the manufacture of other artifacts.[42] After its initial years,[43] the rubber industry swept the region of the Jari, Xingu, Tapajós, Madeira, Purus and Juruá Rivers, leading to waves of northeastern immigrants by the end of the nineteenth century. As a result of the search for new rubber trees, conflict in the Acre region occurred, in addition to the concentration of income in Manaus and Belém. Beginning with the import of shoes, the United States became a major buyer of Amazonian rubber, as did Europe. After 1850, the United States itself began to manufacture its own rubber shoes, thus also becoming an importer of raw materials.[44]

However, inventions such as vulcanization, discovered by the Englishman Thomas Hancock and the American Charles Goodyear in 1844, and the tire by the Irish John Boyd Dunlop in 1888, consolidated the market for Amazonian rubber until the beginning of the twentieth century. After the beginning of the twentieth century, the rubber plantations declined in the Amazon, replaced by new farms in Asia in which the trees were cultivated more productively. Then, as a result of World

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[40] In 1783, there were 153 horse and cattle farms on the Marajó islands; in 1803, there were 226,500 head of cattle (Barata 1973, p. 327).

[41] From 1825 to 1827, various pop-up butchers in the city slaughtered 31,730 head of cattle. In 1828, they slaughtered 11,037 head of cattle, compared with the city's population of 12,500 to 13,000 souls (Barata 1973, p. 329).

[42] After traveling the Amazon River from Quito to Belém, Condamine surprised the Portuguese making milk pumps and syringes in the form of hollow pears, bottles, boots and balls (Tocantins 1960, p. 152).

[43] The first rubber plantations were organized on the outskirts of Belém and the lower Tocantins; later plantations were organized in the Breves and Anajás region of Marajó Islands (Tocantins 1960, p. 168).

[44] In 1855, a total of 178,840 kilos of latex were exported from the Amazon at a price of 36,000 *Réis* per bushel (Barata 1973, p. 320).


Figs. 4.3 and 4.4 A ceramic bowl and rubber tree knife for extraction of latex, most likely of the end of XIX century, Mapuá River in the Marajó Islands – Amazon. (Costa 2015)

War II, in the middle of the twentieth century a new rubber race started, largely driven by American interests.

Rubber tappers employed various tools in the extraction of latex, such as ceramic bowls or rubber tree knives. There were also many natural tools such as the conch shell, which was used to collect the gum, and implements such as forms and chimneys under the *tapiri* for the smoking of the rubber. The effects of the rubber trade are also a legacy that remains relevant in Amazonian society today (Figs. 4.3 and 4.4).

4.4 Cultural and Social Western Transformations in the Amazon

The Amazonian forest has been transformed culturally and socially by Western society over the last 500 years, not only through the direct actions of the European colonizers but also through their control of indigenous and the African manpower.

The first environmental impact of the European colonizers in the Amazon forest was the enslaving of the indigenous people. Starting with the usual barter of drugs and moving on to religious missions for nearly two centuries, Europeans considered the indigenous inhabitants to exist only in two conditions—as gentle people who lived freely and barbarically in the forest, or as Christians who lived semi-free or enslaved to the Europeans. More than being colonizers, the Portuguese wanted to be aristocrats in the new world. Indigenous slaves were used for everything. The men were used to drive canoes, spoon back-country products, herd cattle, graze crops, produce flour, and cultivate sugar cane, rice, and tobacco. The women worked at home as wet nurses, ginning cotton and spinning fabrics, and producing ceramics. With the expulsion of the religious orders from Brazil in 1750, the scene changed because the indigenous people were also freed from slavery.

Subjugation of the native people under the Portuguese flag began in the Amazon world as a series of "just wars," where three types of actions were permitted: bondage, redemption and enslavement. The captives were indigenes imprisoned during conflicts, whereas the rescued were natives exchanged for objects with other groups, after those captured were taken to indigenous missions to work there or in villages. The cultural and social Western transformation of the Amazonian environment had its first manifestation as the indiscriminate use of indigenous labor centered around the European colonizing enterprise. Indigenous slaves were used in camps, houses and in trade wars. However, in addition to the enslaved indigenes, enslaved Africans also would become main impacting agents of Amazonian cultural and social Western environmental transformations, largely at the behest of the European colonizers.[45]

Present since the first European invested in the Amazon, the descendants of enslaved Africans today have become a large part of Amazonian society. The original slaves were taken mostly from African ports such as Angola and Cape Verde through the actions of the trading companies in the seventeenth and eighteenth centuries. The slaves also came from internal trade and were smuggled from places such as Bahia and Maranhão. Official records point to the years 1682–1685 as the time of the first transport of 6000 enslaved Africans from Cacheu and Bissau ports to the Amazon through the Maranhão Trade Company based in São Luis. In 1699, the King of Portugal ordered that all slaves from Guinea be fully dedicated to plowing cane and manufacturing sugar in the mills. This commerce was replaced by the Trade Company of Grão-Pará and Maranhão, Marquis do Pombal project in the years 1756–1778. That project brought more than 14,000 African from the total of approximately 20,000 individual slaves arrived in the period.

Western society has transformed the Amazon forest culturally and socially in the last 500 years for purposes of both trade and industry. The trading companies were another example of exploiting the Amazon region, but it was a monopolized gain that often did not have the same goals as the state. Created by the Marquis of Pombal in 1755, the Trade Company of Grão-Pará and Maranhão, based in São Luis and with an office in Belém, is an example of an enterprise that aimed to concentrate trade and transport of enslaved Africans brought to the New World. These companies were also employed in other activities such as the growth of cotton production[46]

[45] Historical archaeological works have only recently attempted to uncover this past in the region (Costa 2016a, b).

[46] However, there are other hypotheses that identify the British market as the main force behind the cultivation (Shikida 2007).

or the development of new technologies or new products, such as the introduction of white rice, coming from the United States.

However, although these investments were aimed at establishing a long-term productive enterprise in the territory, they briefly met a market demand. When the monopoly of transport and trade was accomplished, the company was soon settled. The Trade Company of Grão-Pará focused beyond the trade and transport of enslaved Africans; it also had several sites in Belém throughout the period for the construction of maritime vessels, such as skiffs, brigantines, sloops, brigs and other ships.

Navigating the Amazon has always been the primary means of transport in the region, employing a number of different vessels, from the old canoes of the natives to the barges from the colonial period, the small ships of the imperial period and the steamships of the republican period. The first great Portuguese navigator was undoubtedly Pedro Teixeira, who previously established the link between Pará and Maranhão internally, following the route Belem, Ourém, Bragança and Turiaçu. In 1637, with 60 soldiers and 2500 indigenous people, he began the epic climb from the Belém to Quito, to which he returned in 1639. The expedition's objective was to explore the river, establish fortifications, relate to the Indians and establish a settlement on the edge of the two crowns called Franciscan.

However, with the exploitation of rubber, boating on the Amazon gained another international role, with the entry of numerous boats manufactured in British shipyards and linking the forest to Europe. Today, water continues to be a primary resource not only as a pathway to connect people, but also, as a nodal point to bring together communities in the Amazon (Fig. 4.5).

Fig. 4.5 Local community of riversides, Jacaré Lake in the Marajó Islands – Amazon. (Costa 2015)

4.5 Last Considerations

We are increasingly convinced that nature and culture today are not separate as previously had been thought since the advent of the modern world.[47] It is easy to see how politics and science actually merge into discussions about the Anthropocene.[48] Man's actions have been transforming the local environment for quite some time, but today this effect has a global-scale dimension. As exposed by Latour, the Anthropocene can be the pathway to escaping the modernity ideal in these times of climate change, where a return to Gaia is not only desirable but also necessary. Only the future can confirm[49] whether the climate debate is a rhetorical war[50]; in the past, many examples can be found to explain this intricate interplay of relationships between humans and nature. However, how new is the Anthropocene?[51] According to the author, the concept is ancient, but the scientific data are new; what differentiates the two is evidently human agency as the ignition process of these natural phenomena. Identifying human action as the cause of a new era is definitely not a semantical problem but one of accepting our responsibility.

The Amazon in is a center of global environmental issues, as is the degradation of nature that is largely contemporary but also historical. Beyond archaeology, environmental history in the Amazon has its beginning in the seminal work of Warren Dean, "Brazil and the Struggle for Rubber: A Study in Environmental History"[52] (Dean 1987). Starting in the 1970s, environmental or ecological historiography developed in the middle of debate about the use of natural resources and has a double aspect: the past investigation and the present critique. Presenting a natural time measurement, the environmental approach to human history is regional in its data collection[53] but global in its interpretation, contributing to a cross-referential study among different social experiences. However, the internal national opposition[54] was another hallmark of the approach because the discourse does not provide another view of the old problems from the historic colonial system.

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[47] To Latour, scientific power represents things and political power represents the subject; however, if you start to cross areas, no one understands what you mean (Latour 1994, pp. 11–35).

[48] Anthropocene is a new geological time, dating since the first human global environmental impact on the Earth until today.

[49] The agency of nature is certainly something that has historically impacted the last century of human existence (Latour 2014a, p. 13).

[50] As the scientific and political debate between humans that live in the Holocene and the terrans that live in the Anthropocene (Latour 2014c, p. 23)

[51] As a materialization of the ephemeral, the Anthropocene also can be called Capitalocene (Latour 2014b, p. 139).

[52] Following an innovative approach to solve the problem of the end of the rubber cycle in the Amazon, the author utilizes the biological pattern of a disease in the rubber trees as a main argument (Oliveira 2010, p. 115).

[53] This enormous field of sources of the environmental history approach is in addition to the written, pictorial, oral, and material records (Drummond 1991, pp. 7–8).

[54] In Brazil, economic history was strongly in opposition to the environmental history (Cabral 2008, p. 115).

After the 1600s the Amazon joined the modern world system and environmental impacts of its natural life also have been found in other places. As ecological consequence of the Amazon's impacts on the world I can cite the introduction of rubber tree in South Asia countries such as Malaysia, Ceylon and Singapore. The rubber tree was first cultivated as an ornamental plant, but by the end of nineteenth and beginning of twentieth centuries rubber farming had acquired an industrial scale and was responsible for intense economic and natural transformations in South Asia. The rubber tree plantation fits well in the long-held small-farmer practice of swidden agriculture in the region, and constitutes a resource bank that can store income to later necessities. Another result of Amazonian rubber tree introduction in South Asia area included maintenance of primary forest cover by traditional rice farmers opposing unnecessary deforestation (Foo 1996; Jong 2001).

Over the half of a millenium of Amazonian occupation, the modern world continues to try to justify itself, today by an environmental discourse, which only tries to hide a sad fact of social inequality. The environmental sustainability of the indigenous people in the Amazon has been scientifically researched since the middle of the twentieth century, when archaeological excavations were used initially to try to explain the present and later the past of these groups, ultimately finding a conjunct of complex societies from the Marajó Islands to the Purus River. The main marker of this new Amazonian pre-colonial paradigm is the anthropogenic dark earth, or ADE,[55] and other biophysical measurements,[56] which also lead to the interpretation that part of the Amazon forest is today a human creation.[57]

In the Amazon, the symbiosis between modern society and the natural environment only occurred in the traditional communities: of the various effects left behind by the recent centuries of occupation, pollution is the major legacy. Pollution is definitively a primary mark of mankind on the planet earth—air, water and soil pollution also constitute part of the human trajectory.[58] However, no other type of pollution has had as many effects as that generated by mining, which has affected humans and the environment since early times. Currently, the extractive reality in the Amazon is confused with a sustainable discourse that does not incorporate the political, economic and social aspects of the environmental group's interest.

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[55] In the Amazon at the time of European contact, more than 83 plant species were domesticated; the other 55 were imported from other regions, out of a universe of 3000 to 5000 non-domesticated species (Clement et al. 2015, p. 2).

[56] Added to this human soil management in the Amazon was also the manipulation of rivers and streams by indigenous people and local communities in pre-colonial and historical times (Raffles and Prins 2003, p. 167).

[57] The political impact of this statement is for one side to empower contemporaneous indigenous people in the Amazon and conversely and simultaneously to disempower the same groups (Troufflard 2013, p. 4).

[58] A black tone in the lungs was found in mummified Paleolithic bodies; the tone was identified as air pollution from lightning fires. In China at least 4000 years ago human feces are used in rice agriculture, polluting the groundwater; an increase in the alkalinity of the soil in Sumerian floodplains between 3500 and 1800 B.C. most likely resulted in the decrease of agriculture (Makra and Brimblecombe 2004, p. 643).

The social–environmental conflict that occurs between a mining company and the maroon community in the plateaus of the Trombetas basin in the middle of the Amazon forest is an example.[59] Since the 1970s, the company has been the leading exporter of bauxite from Brazil[60] in contrast with *Quilombola* communities that have lived in the area since at least the nineteenth century practicing traditional forest extractivism. The company's effect on the community is a case of the biopolitics at work in a world system, reshaping the fauna, flora and people to a Western standard.

However, this mismatch between human idealism and environmental reality in the Amazon is not new. As I have tried to demonstrate in this chapter, many results have occurred from historical attempts to transform the Amazon culturally, naturally and materially according to Western precepts. Two more historical examples, Mazagão and Fordlândia, are thus very illustrative of these attempts. Mazagão was a colonial enclave with a political mandate from the Portuguese crown to occupy the northern margin of the Amazonas River. Transporting an entire city in the middle of eighteenth century, from Morocco to what is today called Amapá, the Portuguese administration was not capable of overcoming the difficulties posed by the foreign population in addition to the environmental constraints of the region. Conversely, Fordlândia was a capitalist enclave representing the economic interests of North American industry that tried to cultivate sugarcane in the Tapajós River. Constructing an entire village at the beginning of twentieth century, the foreign enterprise was also not able to overcome the difficulties of production in the context of similar environmental constraints of the region.

Finally, the environmental impacts of Western practices and particularly their material legacy are a constant presence in the Amazon.[61] The impacts are characterized by the attempt to appropriate the wilderness through an economic appropriation of pristine resources; by the domestication of nature, such as the introduction of new non-human collectives and human enterprises; and by the transformation of the biophysical environment based on the modern concept of anthrome[62] creation.

References

Arregui, A. (2015). Amazonian quilombolas and the technopolitics of aluminum. *Journal of Material Culture, 20*(3), 249–272.

Barata, M. (1973). *Formação Histórica do Pará*. Belém: Universidade Federal do Pará.

Bentes, D. S. (2007). *Primeiras Imagens da Amazônia*. Manaus: Edições do Governo do Estado do Amazona.

[59] At a macro level, the State, and at a micro level, the Company cause the economical end environmental transformations in the region (Arregui 2015, p. 266).

[60] Actually, Brazil remains the major exporter in the world, accounting for 83 different types of minerals from the oldest geological terrains on the planet (Machado and Figueiroa 2001, p. 21).

[61] A review of the historical archaeology in the Amazon can be seen in (Costa 2017).

[62] Anthropogenic biomes; for more, see http://ecotope.org/ accessed in 03/02/2017.

Cardoso, A. (2015). Spices in Portuguese Amazon region: Vegetable retail and Atlantic trade in the end of the Spanish Monarch. *Revista Tempo*.
Carita, R. (2013). The sugar route – Madeira, Atlantic Islands and Brazil. In M. V. Gomes & T. M. Casimiro (Eds.), *On the world's routes – Portuguese Faience (16th–18th centuries)* (pp. 160–180). Lisboa: Instituto de Arqueologia e Paleociências.
Carneiro, E. (1980). *A conquista da Amazônia*. Rio de Janeiro: Civilização Brasileira.
Carter, N. (2007). *The politics of the environment: Ideas, activism, policy* (2nd ed.). New York: Cambridge University Press.
Clement, C. R., Denevan, W. M., Heckenberger, M. J., Junqueira, A. B., Neves, E. G., & Teixeira, W. G. (2015). The domestication of Amazonia before European conquest. *Proceedings of the Royal Society B, 282*, 20150813.
Costa, D. M. (2010). *Water and war at Pyreneus mountains: Historical eco-archaeology of a goldmine village in the end of nineteenth century, Mid-Western Brazil.* (PhD), University of Florida, Gainesville. Retrieved from http://uf.catalog.fcla.edu/uf.jsp?st=UF005053949&ix=nu&I=0&V=D
Costa, D. M. (2011a). Archaeo-environmental study of the Almas river: Mining pollution and the Cerrado biome in the end of the nineteenth century in Mid-Western, Brazil. *Journal of Archaeological Science, 38*(12), 3497–3504. https://doi.org/10.1016/j.jas.2011.08.012.
Costa, D. M. (2011b). *Water and War at Pyreneus Mountains: Historical Eco-Archaeology of Lavras do Abade*. Saarbrücken: LAP Lambert Academic Publishing.
Costa, D. M. (2012). Arqueologia da Mineração nas Lavras do Abade: entre propostas e práticas. *Vestígios. Revista latino-americana de arqueologia histórica, 6*(1), 83–112.
Costa, D. M. (2013). Eco(Arqueo)logia Histórica nas Lavras do Abade: Patrimônio Cultural e Natural. *Amazônica, 5*(1), 38–53.
Costa, D. M. (2014). Historical Archaeology of Lavras do Abade: An Environmental Conflict in Nineteenth-Century Brazil. *International Journal of Historical Archaeology, 18*(1), 20–36. https://doi.org/10.1007/s10761-013-0245-y.
Costa, D. M. (2015). *Guerra e Água na Serra dos Pirineus: Arqueologia Eco-Histórica das Lavras do Abade*. Goiânia: Editora da PUC Goiás.
Costa, D. M. (2016a). Archaeology of the African Slaves in the Amazon. *Journal of African Diaspora Archaeology and Heritage, 5*, 198–221.
Costa, D. M. (2016b). Arqueologia dos Africanos Escravos e Livres na Amazônia. *Vestígios – Revista Latino-Americana de Arqueologia Histórica, 10*, 69–91.
Costa, D. M. (2017). Historical archaeology in the Amazon: The Murutucu Sugar Cane Mill Field-School Project. *International Journal of Historical Archaeology, 21*(3), 674–689.
Costa, D. F. d., & Arenz, K. H. (2015). *Patrimônio e História: os Jesuítas na Amazônia*. Belém: Paka-Tatu.
Cruz, E. (1973). *História do Pará* (Vol. 1). Belém: Governo do Estado do Pará.
de Carvalho Cabral, D. (2008). Substantivismo econômico e história florestal da América portuguesa. *Varia História, 24*(39), 113–133.
de Jong, W. (2001). The impact of rubber on the forest landscape in Borneo. In A. Angelsen & D. Kaimowitz (Eds.), *Agricultural technologies and tropical deforestation*. Wallingford: CAB International.
de Oliveira, J. R. M. (2010). A Luta pela Boraccha no Brasil e a Histgória Ecológica de Warren Dean. *Revista Territórios e Fronteiras, 3*(2).
Dean, W. (1987). Brazil and the Struggle for Rubber: A Study in Environmental History. Cambridge: Cambridge University Press.
Drummond, J. A. (1991). A História Ambiental: temas, fontes e linhas de pesquisa. *Estudos Históricos, 4*(8), 177–197.
Filho, A. A., Júnior, J. A., & Neto, J. M. (2001). *Pontos de História da Amazônia*. Belém: Paka-Tatu.
Foo, T. N. (1996). *The international natural rubber agreement and its implications for the Malaysian natural rubber industry* (Masters thesis). University of Malaya, Kuala Lumpur.

Gadelha, R. M. A. F. (2002). Conquista e ocupação da Amazônia: a fronteira Norte do Brasil. *Estudos Avançados, 16*(45), 63.
Garcia, G. L., & Lobato, E. (2011). *Memória dos Engenhos do Abixo Tocantins*. Belém.
Guzmán, D. d. A., & Hulsman, L. A. H. C. (2016). *Holandeses na Amazônia (1620–1650): documentos inéditos*. Belém: IOE.
Hulsman, L. (2011). Swaerooch: o comércio holandês com índios no Amapá (1600–1615). *Revista Estudos Amazônicos, VI*(1), 178–202.
Latour, B. (1994). *Jamais Fomos Modernos: Ensaio de Antropologia Simetrica*. Rio de Janeiro: Editora 34.
Latour, B. (2014a). Agency at the time of the Anthropocene. *New Literary History, 45*, 1–18.
Latour, B. (2014b). *Anthropology at the time of the Anthropocene – a personal view of what is to be studied*. Paper presented at the American Association of Anthropologists, Washington.
Latour, B. (2014c). Para distinguir amigos e inimigos no tempo do Antropoceno. [Thinking the Anthropocene]. *Revista de Antropologia, 57*(1), 11–31.
Lindebaum, S. (1987). Loaves and fishes in Bangladesh. In M. Harris & E. B. Ross (Eds.), *Food ans evolution: Toward a theory of human food habits*. Philadelphia: Temple University Press.
Machado, I. F., & Figueiroa, S. F. d. M. (2001). 500 years of mining in Brazil: A brief review. *Resources Policy, 27*, 9–24.
Makra, L., & Brimblecombe, P. (2004). Selections from the history of environmental pollution, with special attention to air pollution. *International Journal of Environment and Pollution, 22*(6), 641–656.
McKenna, T. (1992). *Food of the gods: The search for the original tree of knowledge a radical history of plants, drugs, and human evolution*. New York: Bantam.
Raffles, H., & Prins, A. M. G. A. (2003). Further reflections on Amazonian environmental history: Transformations of rivers and streams. *Latin American Research Review, 38*(3), 165–187.
Shikida, C. D. (2007). Apontamentos sobre a Economia Política da Companhia Geral de Comércio do Grão-Pará e Maranhão. *Revista de Economia e Administração, 6*(2), 75–190.
Tocantins, L. (1960). *Amazônica, Natureza, Homem e Tempo* (Vol. Conquista). Rio de Janeiro: Conq.
Troufflard, J. (2013). *A reflection on archaeology and sustainability in the Brazilian Amazon*. Paper presented at the The 3rd World Sustainability Forum Canada.

Chapter 5
Indigenous Charcoal Production and Spanish Metal Mining Enterprises: Historical Archaeology of Extractive Activities and Ecological Degradation in Central and Northern Mexico

Patricia Fournier Garcia

Abstract The Iberian invasion of the New World resulted in land-degradation processes. Human agency associated with silver mining and the two methods involved in refining (smelting and amalgamation) had dramatic environmental consequences. The need for fuel used in one method led to the deforestation of vast areas where soils were further eroded. The use of mercury in the other produced toxic wastes and tailings in mining towns and regions, poisoning soils, sediments, and the water table. Based on the detailed analyses of historical records, surveys, and archaeological excavations, we discuss how the Otomí Indians of the Mezquital Valley in central Mexico became producers of charcoal required in the mines located in that valley, and show how mercury was introduced in the mining regions of northern Mexico using a case study from Zacatecas, in Pánuco, a mining town founded by the Oñate family.

5.1 Pre-Columbian and Post-Conquest Mining in Mexico

Simple metallurgy methods were implemented in pre-Columbian Mexico to collect surface- or river-metal nuggets and grains. Ornaments made of copper, gold, silver, and some of their alloys were produced by cold-working, hammering or sheeting, and casting, including soldering, welding, and inlaying. Moreover, some metal tools and weapons, predominantly copper items, had been manufactured probably since the seventh century A.D. in western Mexico. The use of metals objects was not widespread; indigenous societies gave them more symbolic meaning than economic

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or utilitarian importance, and metallurgy was practiced on a small scale (Bernstein 1964; Maldonado 2006).

Once Christopher Columbus landed in the New World in 1492 and precious metals were found in the newly discovered territories, the Spanish Crown became obsessed with finding gold, silver, and treasure. To that end, in 1519, Hernán Cortés set sail from Cuba to Mexico, a vast territory that became one of the most important and richest possessions of the Spanish Empire in the Americas.

Following the 1521 conquest of Mexico-Tenochtitlan, the Aztec capital and core of a thriving empire dominating most of central and southern Mexico, the indigenous population of these areas as well as those that were conquered to the north in the late sixteenth century and early seventeenth century were subjected to forced heavy labor and tribute and taxation systems. This labor included the growing of newly introduced, nonindigenous crops; raising livestock; and working in mining activities, which resulted in the deaths of many natives (Gibson 1964; Melville 1994). Moreover, diseases of European origin decimated the indigenous population to different degrees; in some places the population decreased, in others it remained stable, and in some it increased, which suggests that the impact of the epidemics was not a homogenous process and that it was definitely higher in regions with the highest population density (Fournier Garcia and López Aguilar 2015). This demographic catastrophe was exacerbated by environmental changes when a drastic drought affected North America in the mid-sixteenth century due to extreme climatic conditions resulting from irregular precipitation cycles. Also, an indigenous virus causing hemorrhagic fevers dramatically affected highland populations (Acuna Soto et al. 2002).

5.2 Mining and Selective Land Depredation in Mexico

Technology may be viewed as a means by which natural resources are transformed into raw materials, and such production may cause environmental damage and large-scale depredation of resources and land (e.g., Gruen 2001).

The quest for precious metals and treasure led to the conquest and control of territories located north, west, and south of the capital of New Spain. For economic reasons, the main goal was to mine gold, which turned out to be scarce, although silver and lead were abundant. Throughout the colonial period (1521–1821), metal extraction proliferated in different regions (Fig. 5.1); however, Zacatecas, Oaxaca, Taxco, and zones north of the Basin of Mexico located in contemporary Pachuca and the Mezquital Valley (Ixmiquilpan, Cardonal, and Zimapán) were among the most important mining districts (Bakewell 1971; Probert 1987).

Mining techniques introduced in the 1530s by the Spanish colonizers depended on the quantity of the veins and the quality of the ores discovered. By 1548, the Zacatecas mines to a lesser extent became the main source of silver in the viceroyalty, whereas the Mezquital Valley mostly provided lead and silver (e.g., Bakewell 1971, 1984).

Fig. 5.1 Map of Mexico showing the Royal or Silver road, and cities or towns mentioned in the text

Many mining settlements or *reales de mina* became important towns or cities as a result of their concentration of wealth, although many of the owners of the most prosperous mines lived in the capital of New Spain. The discovery of ores would give rise to the Royal Road or Silver Road that connected the capital to the northern provinces, the south, and through different branches to the Pacific and the Gulf of Mexico settlements and ports of call. These wagon trails opened as the Spanish conquest progressed and advances occurred in the northern areas. Eventually, the Silver Road extended to Fresnillo, Sombrerete, Nombre de Dios, Durango, and Valle de San Bartolomé, then deviated toward Chihuahua and up to the Paso del Norte, Albuquerque, and Santa Fe (Powell 1984).

All over New Spain mining villages proliferated, being nodes for the foundation of towns, cities, missions, agro-pastoral ranches, and smelting settlements, some of which were rich in precious metals, making them sources of huge wealth. Silver and gold were used, among other things, to finance expansionist incursions, to construct monumental civil and religious buildings, as well as to create a wealthy New Spain upper class and to guarantee full coffers for the Crown in the metropolis.

The distribution of precious metals passed through the capital, which was the center of all transactions (Fournier Garcia and Blackman 2010).

To supply the mining towns, agricultural and livestock ranches and haciendas[1] (agricultural estates) for grain and meat flourished in the mining regions. Hence, agricultural intensification and overgrazing resulted in further degradation of land and water resources.

Mines in New Spain were complex operations requiring significant human and natural resources. Once tunnels were opened by slaves, tribute Indians, and hired workers, wood was a necessity for beams and ladders for galleries and shafts. Containers to carry the extracted ores out of the mine were required, such as hide buckets, agave fiber baskets, and sacks. To extract precious metals from the ore, many raw materials and facilities were required: lead (litharge or lead monoxide) as a flux to refine the silver in furnaces; water, mercury, salt, copper, and iron sulphates (*magistral*); drag stones and horse mills; stables for mules and horses; tanks; paved yards; ore-refining facilities in general; store rooms; chapels; and living quarters for the administrators, accountants, and other company officers (e.g., Bakewell 1971; Bernstein 1964). A major raw material requirement was wood for the production of charcoal.

Initially, smelting was employed to extract silver from high-yield ores: first the ore was crushed by hand or a mechanical mill and lead was added, then the particles of powder were packed into vertical Castilian furnaces made of rocks or adobe; and to that end, considerable amounts of charcoal were required. Since this process did not produce pure silver (because it contained lead impurities from the ores or as a result of adding this metal as a flux), further beneficiation was required, carried out in a reverberatory furnace, using charcoal as fuel inside the firebox (e.g., Bakewell 1984).

For silver-ore amalgamation, a process known as the yard or *patio* method or Medina's process— after the Sevillian Bartolomé de Medina who introduced it to New Spain in 1555—became widely. It was profitable since it was possible to refine most low-grade silver ores. Valerio Ortega (1902: 276–277) describes all the details of this method:

> The ore extracted from the mine is sorted by *pepenadores* [pickers] who break the large pieces with hammers, rejecting those which contain no ore, set aside the very rich to be smelted, and deliver the rest to be crushed and pulverized for direct amalgamation in the *patio* [yard]. The broken lumps, of about fist-size, are first ground in Chilean mills, and then reduced, in *arrastras* or *tahonas* [mills with cogwheels moved by horses or mules], to fine slime [sic slurry].
>
> After the… [slurry] has acquired a suitable consistency by the evaporation, through the sun's heat, of a part of the water which it contained, it is spread upon the *patio* or amalgamating-floor, where it is mixed with 5% or 6%, of common salt. The next day a certain amount (depending upon the nature of the ore and the season of the year) of

[1] *Haciendas* were agro-pastoral or mining "… estates, operated by a dominant … owner and a dependent labor force, organized to supply a small-scale market by means of … capital, in which the factors of production are employed not only for capital accumulation but also to support the status aspirations of the owner" (Wolf and Mintz 1957: 380).

> Bluestone (cupric sulphate) is added; and, immediately afterward, mercury, in the proportion of eight units to one of silver contained in the mineral, squeezed through a piece of thick cloth or chamois skin, and spread over the pulp or *torta* [roughly equivalent to a cake]. These chemicals are thoroughly mixed with the [slurry] by means of horses or mules trampling the *torta* — an operation called the *repaso*, and repeated daily until the treatment is finished. The time required is from 2 to 5 weeks, depending upon the quality of the ore, the temperature of the locality, and the period of the year.
>
> Samples are taken at intervals for assay by washing in a vanning-bowl; and when the tests show that amalgamation is too slow, more bluestone is added; if it be too active (from the presence of copper sulphate in excess, as indicated by gray color and floured mercury), it is retarded by the introduction of lime, cement-copper or wood-ashes. At the end of the process, it is usual in some places to make a final considerable addition of mercury, to collect the grains of amalgam.
>
> Amalgamation being finished, the *torta* is transferred to deep circular stone vats, or settlers, through which water is passing, agitated by a revolving paddle. The amalgam and other heavy metalliferous materials collect in the bottom, while the light, earthy impurities are held in suspension and carried away.
>
> The fluid amalgam thus obtained is squeezed through canvas bags, whereby the excess of mercury is forced out, and there remains a solid or pasty argentiferous amalgam, containing about one-fifth of its weight of silver. This is compressed into triangular segments, which are transferred to the *quemaderas*, or retorting-houses, for the separation of the mercury by heat.

Bakewell (1984: 166) clarifies that for the cake, "Final separation of silver and mercury occurred by volatilization under a metal or clay hood, heat being applied… from below, causing the mercury to vaporize. The hood itself was cooled so that the vapor condensed on the inner surface and metallic mercury was recovered."

It is important to mention that the amalgamation process was applied exclusively to silver ores free of lead; therefore smelting was continuously used all over New Spain for low-scale mining, and by the late eighteenth century up to 36% of silver production depended on smelting (Guerrero 2016), with large amounts of charcoal being consumed in the process.

5.3 Indigenous Charcoal Production in Central Mexico: The Otomí Indians from the Mezquital Valley

The Mezquital Valley is part of the Central Mexican Highlands within the physiographic area of the neovolcanic axis of the central Mexican plateau. During the eighteenth century, the most important territorial jurisdictions of the region included Tula, Ixmiquilpan, Tetepango, and Huichapan (Fournier Garcia and Mondragón 2003). Most of this region has shallow soils, scarcity of permanent water sources, and low precipitation, except in zones with permanent rivers.

The Otomí Indians have inhabited the region at least since the seventh century A.D. based on DNA analyses. They had permanent settlements with monumental architecture. They were part of the multiethnic urban center of Tula, but scattered hamlets and villages were the main features throughout the pre-Columbian period.

Resource exploitation was apparently efficient enough to support a relatively large population, perhaps as many as half a million inhabitants in the sixteenth century. The region fell under the control of the Aztec Empire and was divided into a series of tributary provinces and independent states that paid tribute to their lords in the form of woven agave fiber, sandals, maize, beans, *Salvia hispanica*, amaranth, lime, and agave honey, among other items that reflect a level of specialized production as well as an emphasis on rainy-season agriculture and the specialized use of agave (Fournier Garcia and Mondragón 2003).

After the Conquest, Spanish forms of political, legal, ideological, and economic control affected the way of life of the Otomí. Indigenous communities experienced deep transformations in their basic subsistence and production patterns when the Spanish Crown granted European settlers most of the fertile lands of the region, dispossessing the indigenous towns of their most valuable resources by appropriating water supplies, the best irrigable fields, and the best grazing lands (Fournier Garcia and Mondragón 2003). New towns, ranches, and haciendas were founded, including mining settlements.

The landscape of the Mezquital Valley was reconfigured at different levels of local and regional specialization, depending on the presence of resources and the vision and interests of the Spanish settlers. Broadly speaking, the eastern zone was the center of mining and the raising of sheep and goats; and the western zone, where grasses and forests of oak and pine prevailed, was dedicated to livestock and horse breeding (Fournier Garcia and López Aguilar 2015).

By the mid-sixteenth century, Ixmiquilpan became part of a mining subregion where several mining towns were founded. The most important were Zimapán and Cardonal, where mainly lead was extracted as well as silver, gold, zinc, and arsenic-bearing minerals in low proportion (Gerhard 1986; Ongley et al. 2007). Minor mining centers included Cruz de los Alamos and La Pechuga that by the eighteenth century were integrated to the Zimapán district (Gerhard 1986; Tamayo 1943). Some of the owners of these companies had vast lands in the Mezquital Valley and nearby areas, dedicated to agriculture, and in addition, they had mines in Guanajuato and Zacatecas (e.g., González Dávila 2003; Vergara Hernández 2010). Extractive works at the mines required indigenous labor, which in the early days of exploitation meant that forced labor was used and even expanded (Fournier Garcia and López Aguilar 2015).

The intense construction activity in the northeast of the Mezquital Valley had negative effects on the ecosystem due to the demand for wood and stone to build churches, monasteries, and roads, as well as for mining in the habilitation of both open-pits and galleries as well as to build mills, winches, and diverse machinery and instruments (Studnicki-Gizbert and Schecter 2010). Wood was not only indispensable in the daily lives of residents of both European and indigenous origin; it was extremely important to the production of charcoal. Charcoal was essential to the furnaces that were used for continuously in the silver-refining process (Lacueva Muñoz 2010). This was the only viable method that could be used in the Zimapán, Ixmiquilpan, and Cardonal mines since the ores contained considerable amounts of lead, which ruled out the use of the mercury process (Mendizábal 1941).

The production and sale of charcoal by the Indians allowed them to count on income that they could use for the payment of taxes and tithes, to support their families, and to buy corn when required, so that those who managed to learn Iberian techniques for charcoal production, had a source of income at hand if crops failed (e.g., Ayala 2007), even if it was only seasonal.

By the eighteenth century, the extractive activities in the mining centers of Zimapán and Cardonal were combined with agriculture, especially in the haciendas and ranches producing the grains and fodder required to feed the miners and draft animals required to work both inside the mines or to process the ores for metal beneficiation. In these mining zones, there were villages and minor settlements, mainly of Otomi Indians as well as some Spaniards and mestizos who lived in small rural settlements. These individuals carried out commercial activities; produced agave-fiber textiles, cords, sandals, and other items; fermented agave sap (*pulque*, a mildly alcoholic beverage widely consumed by Indians and mestizos); or worked as muleteers (Fournier Garcia 2007; Molina del Villar and Navarrete Gómez 2007).

Charcoal production in the Mezquital Valley for use in refining metals started early in the colonial period. According to a chronicle about Zimapán dating to 1579, deforestation of the neighboring mountainous zones was a problem since pines, oaks, and poplars were continuously cut to produce charcoal, and mesquites were threatened by overexploitation of forest resources (e.g., Acuña 1985). Even though local authorities issued ordinances to protect mesquites, in semi-arid areas of New Spain mesquite wood was favored for charcoal production because of its high thermal performance compared to other species, and because both the tree and its roots could be transformed into charcoal (Fournier Garcia and López Aguilar 2015; Studnicki-Gizbert and David Schecter 2010). In the Zipamán subregion, in 1795 there were more than 100 refining furnaces (Sonneschmid 1983: 62); hence tons of charcoal were used.

Historical and ethnographic information for Mexico and Europe (e.g., Argueta Spínola 2006; Biringucci 1540) provides the basis for understanding traditional, non-industrial, small-scale charcoal production. Charcoal-makers build earth-mound kilns of different sizes and forms—round, oval, or square —directly on the ground. A cone is formed with piles of firewood covered with dry leaves, sticks, or straw, and then completely covered with a layer of earth except for a few holes that function as chimneys. Firing depends on the amount of firewood: for example, for 4 tons of wood fired between 400 and 600 °C, the process lasts about 12 days, and it may take up to 9 days to cool the kiln. The earth employed to cover the kiln can be used multiple times, and it gets darker in color each time it is used. Charcoal production usually is a seasonal activity. Firewood must be dry, and if there are no special facilities to store it indoors until it dries completely, it is not feasible to produce this fuel during the rainy and cold seasons.

Based on historical information for different mining regions of New Spain, although the activities of charcoal-makers were not continuous, this craft was part of the diversified domestic economy of indigenous and European-descent peasants. They combined agricultural activities and small-scale livestock-raising with charcoal-making as collective endeavors, with men, women, and children working

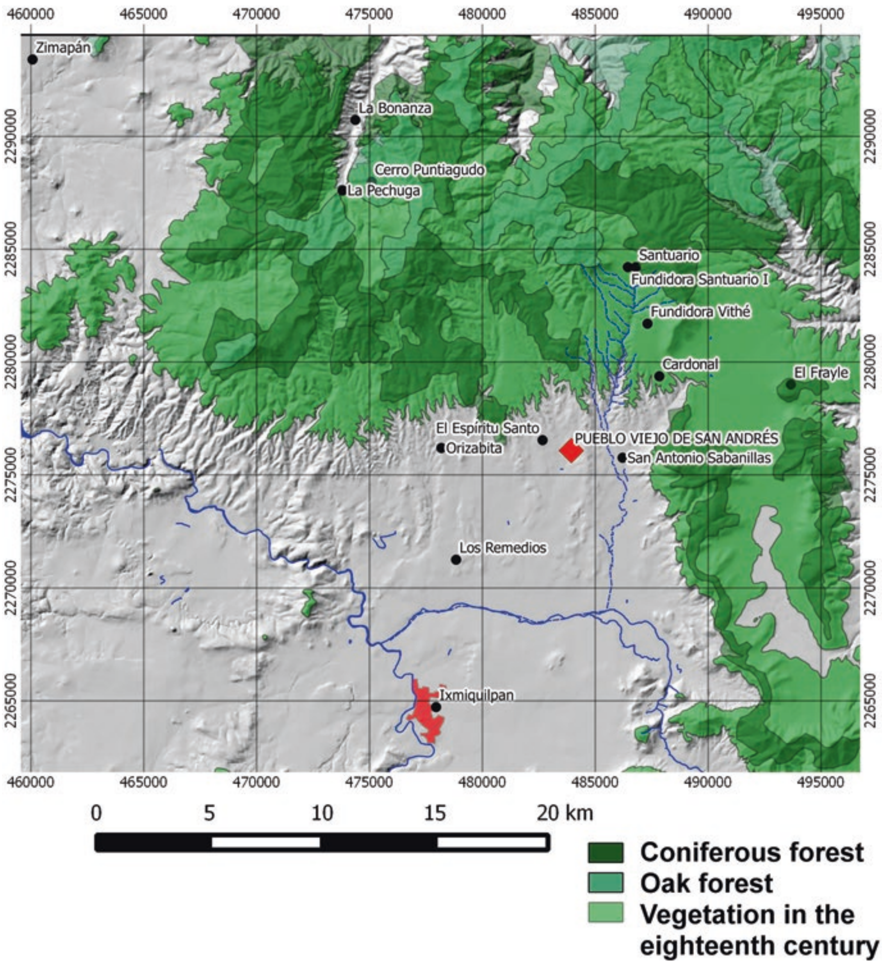

Fig. 5.2 Location of Pueblo Viejo San Andrés and major mining centers in the eighteenth century. (Adapted from Fournier Garcia and López Aguilar 2015)

to make a living (e.g., Studnicki-Gizbert and Schecter 2010). This was the typical extended-family organization of the Otomí Indians in the Mezquital Valley during post-conquest times.

To date, there is only one report on the archaeological visibility of charcoal production sites in Mexico—the study carried out in the Mezquital Valley based on surveys and excavations at the ruins of a hamlet (Fournier Garcia and López Aguilar 2015).

Pueblo Viejo San Andrés (Fig. 5.2), as the locals name the ruins of an old settlement, is located in the Ixmiquilpan district. The site is composed of 11 structures, the remains of another and five mounds (Fig. 5.3). This hamlet is located on a small and eroded hill with shallow soils, bordered by alluvial fans where xerophytic

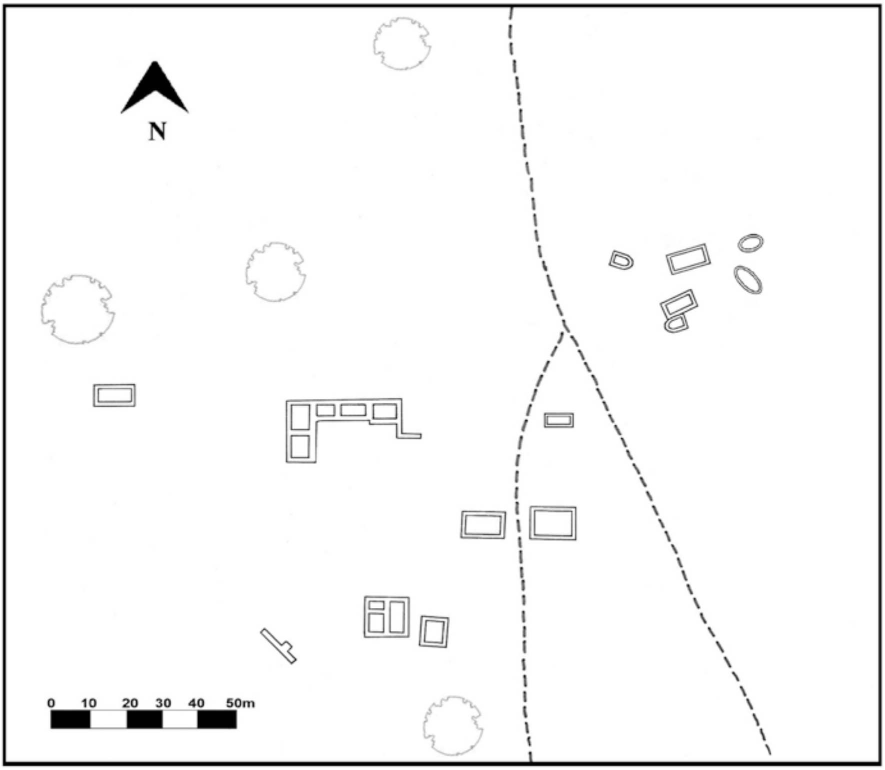

Fig. 5.3 Ruins of Pueblo Viejo San Andrés

shrubs and cacti grow. Toward the center of the site, there are four structures with several rooms, forming a small square covering 35.0 m (east-west) by 15.0 m (north-south). A displaced engraved stone was found with the legend "May 28, 1791," in addition to a carved cross. These elements may have been part of an eighteenth-century chapel, common in this region since the Otomí mixed Catholic and traditional ideas dedicating these buildings to their ancestors.

To the east of this square, there is a rectangular structure, the largest of the site, 25.0 m (east-west) by 8.0 m (north-south). To the south of the square, there are two structures. One is an irregular pentagonal, 10.0 m in the longest axis and 7.0 m in the shortest. The other structure is rectangular, oriented to the north and composed of five rooms. To the southwest of the square, there are alignments of a possible structure that together with the two previous constitute the southern limits of the square.

The rest of the buildings are located around the latter architectural complex. To the northwest is a set of five structures. Two of them are oval, two are rectangular, and the last one is quadrangular, comprising two rooms. Between this set of structures and the structure located to the east of the square, there is another rectangular building, 8.0 m long (east-west) by 4.0 m wide (north-south). To the west of the chapel, there is another structure measuring 10.0 m (east-west) by 6.0 m (north-south).

Four ash mounds were found, whose dimensions are on the average 15 by 10 m, and from 1.50 m to 3.0 m in height. Based on archaeological excavations, these mounds consist of silty-clay material, ash, lime, and many fragments of charcoal. These are the remains of earth-mound kilns used to produce charcoal, evidence that the inhabitants of this hamlet were charcoal-makers, who probably sold to the Cardonal, Ixmiquilpan, or Zimapán mines.

The ceramic collections include majolica sherds of types that date from the early seventeenth century to the mid-nineteenth century and a few fragments of British nineteenth-century transfer-printed whitewares. These ceramics were associated with status in New Spain but tended to be more affordable during the Republican period (post-1821); hence the inhabitants of this hamlet had the purchasing power to consume expensive ceramics since charcoal production might have been a profitable business.

According to the information registered in archival sources (Fournier Garcia and López Aguilar 2015), during the eighteenth century in the Ixmiquilpan district legal disputes were common among the vice-regal authorities; several Indian towns and Otomí caciques (heads of Indian towns, villages, and hamlets) vied for the right to cut oak trees to make charcoal. However, Otomí charcoal-makers depended on the prosperity of the regional mines, so the fluctuations in mining production would have had a negative effect on the development of their craft and, therefore, on their ability to have economic resources that would allow them to prosper. Perhaps the abandonment of Pueblo Viejo San Andrés was a result of the decline in extractive activities toward the mid-nineteenth century; hence the inhabitants of the hamlet were forced to seek other alternatives to survive in another site. The archaeological evidence shows that the occupation of the site seems to have been truncated in the second half of the nineteenth century, although ceramic types and wares are not sufficiently diagnostic to determine exactly when.

5.4 Spanish Silver Mining in Zacatecas

The discovery and exploitation of silver ores led to a significant expansion to the north and the emergence of major population centers. The Zacatecan silver veins was the result of Cristóbal de Oñate's efforts, who was Nueva Galicia's vice-governor; and in 1546 he sent an expedition from Guadalajara composed of Indians and black slaves as well as Spanish troops that were captained by Juan de Tolosa, accompanied by Miguel Ibarra to do some exploration. This invasion resulted in the location of important veins, including one that was found in 1548 by Diego de Ibarra, Miguel's nephew, about 4 km northeast of Zacatecas, the same year, on the Day of All Saints, when the Pánuco vein was also discovered (Rivera Bernardez 1883). Miguel Ibarra's nephew, Francisco de Ibarra, explored vast northern regions, and founded the province of Nueva Vizcaya, where he discovered rich veins leading to the establishment of more mining towns (San Martín 1989). Durango became the capital of Nueva Vizcaya, the northern frontier of New Spain in the 1530s, and with time it became an important urban center, eclipsed in the seventeenth century by the thriving mining center of Parral that had a large region rich in precious metals, including the San Bernabé and San Bartolomé mines.

Regarding the Oñate family, in 1623 (Bloom 1939) Juan de Oñate wrote a letter to the king where he describes many aspects about his father's merits, Cristóbal de Oñate, who apparently was born in 1504 in the heart of a noble family from Biscay in the Basque region; and in 1524, when he was still very young he became one of the conquerors along with Hernán Cortés (Zumalde 1998).

In 1531, while being subordinated to Nuño de Guzman, Cristobal de Oñate founded the city of Guadalajara, the capital of Nueva Galicia. As cavalry captain, from 1539 to 1542 Cristobal de Oñate led the conquest of the hostile indigenous tribes living in the Mixtón area along with 300 soldiers, including Aztec and Tlaxcalan allies from central Mexico; later, as captain general, he led more than 80,000 men in the war that took place in Jalisco. His title was ratified by the Viceroy Antonio de Mendoza, and he carried out the conquest of Nueva Galicia, bringing peace to this kingdom and eventually becoming its vice-governor (Bakewell 1971; Bloom 1939; Mota Padilla 1973).

Along with Juan de Tolosa, he was one of the first settlers in the Zacatecas' mines once the Spanish conquered the region and managed to repel hostile Indians. Cristóbal de Oñate basically settled in Pánuco, although he lived on horseback between that place, Zacatecas, and the vice-royalty capital. He died in 1567 at his home, "Los asientos de Oñate" in Pánuco, where he was buried in the church (Zumalde 1998).

According to the aforementioned letter (Bloom 1939), Juan de Oñate (who was born around 1552 in Pánuco) married Isabel Cortés Tolosa, daughter of the aforementioned Juan de Tolosa and Leonor Cortés Moctezuma (granddaughter of one of the last Aztec emperors), who was Hernán Cortés's natural child. As soon as he could, while still a very young man, he took up arms and participated in the pacification of hostile Indians along with the Viceroy Luis de Velasco. He was ordered by that viceroy to discover and take over the mines of San Luis, Chicu, and Charcas, using his own resources. In 1592 he was ordered by the King Philip II to go to the provinces and kingdoms of New Mexico, which he conquered over the course of 13 years, spending a considerable amount of his own money. Moreover, he discovered many other provinces, and he reached the Pacific shores, in spite of the fact that he did not get the support of men and capital that he requested from the king in 1602. When he was asked to return to New Spain, he was accused of several charges, and he was given a considerable fine, which had to be paid immediately, and sentenced to perpetual exile in New Mexico (Zumalde 1998).

Once he got back to Zacatecas in 1613, he found that during his absence and due to mismanagement, the mines that belonged to his family as week as metal extraction and beneficiation were about to be abandoned, so he set in motion several machines to revitalize the exploitation of ores, producing between that year and

1623 more than 137,000 ingots, that yielded the Crown nearly 130,000 pesos in gold because of the royal tax (Bloom 1939; Zumalde 1998).

Regarding the mines of the mining settlement of Pánuco, which Juan de Oñate inherited from his mother, Catalina de Salazar, from December 1614 to late 1622, for the royal tax to the Crown alone he paid more than 51,000 silver ingots. Thus, he was able to gain back the favor of the king, and he was granted titles, prestige, and authority as mine inspector of the whole kingdom but without any pay; besides this he was honored with the habit of the order of St. James of the Sword, a knighthood usually conferred to Catholic noblemen in Spain. Unfortunately, the Governor of New Mexico died in 1627 in Spain when he was inside a mine that collapsed (Bloom 1939; Zumalde 1998).

On the other hand, two sons of Francisco Perez de Ibarra, who was Castile's Constable Judge, and Maria Perez Marquiegui, moved to New Spain. The first one to arrive there was Miguel de Ibarra, who was Nuño de Guzman's captain. The second son, Diego de Ibarra, was born in Éibar, Guipuzcoa, in the Basque region, probably in 1520 or 1521. In 1540 he arrived in New Spain, and he joined his brother; in 1556 he married Ana de Castilla, Luis de Velasco's daughter, who was the Viceroy at that time, and then he went to the north. Diego de Ibarra and Oñate lived in the mining town of Pánuco (Mechan 2005; Porras Muñoz 1968).

Diego de Ibarra became mayor of Zacatecas; and, thanks to this position, he attracted Basque settlers who took an active part in mining (Azcona Pastor 2004: 36). He was a promoter of the worship to the Holy Virgin Mary in Zacatecas, and he was also known for his generosity to charities to and several religious institutions, such as the parish church at Pánuco, which he built and endowed (Porras Muñoz 1968).

With 200,000 pesos, he financed the conquest of Nueva Vizcaya—undertaken by his nephew, Francisco de Ibarra (ca. 1539–1575), which started in 1554—and departed from Zacatecas. This man from Éibar earned the lifetime designation of governor and captain general; he died from tuberculosis, childless, without paying his the debts to his uncle, who actually succeeded him in 1576 in his position as governor of the provinces of Copala, Nueva Vizcaya, and Chiametla. It was detailed in his will that among his assets there were two water mills and mines in Pánuco. These smelters and mines, like many others in San Martín, Zacatecas, and Sombrerete, and several properties in Nueva Vizcaya, including ranches, along with substantial capital, were kept by the Ibarra family until 1610, when their primogeniture decreased dramatically, and the Pánuco mines, as well as other assets, were sold (Mechan 2005; Porras Muñoz 1968).

5.5 Silver Mining in Pánuco

Nowadays Pánuco, located less than 18 km from Zacatecas, is a small agricultural town, but there are still some remnants of its old mining boom, and small amounts of silver are still extracted from the tailings. Pánuco is located in the Zacatecan mining district at 2125 m above sea level, in a semiarid zone. In Pánuco the Buen Suceso Creek is a temporary stream fed by low precipitation (Echavarría Cháirez et al. 2004; Ponce 1985).

Pánuco's downtown is still standing, with many nineteenth and twentieth-century modifications; the church is still in use and part of the eighteenth- to nineteenth-century style living quarters for the priests have been preserved. As modest as it might look today, this was the See of the first Zacatecan parish, which was founded in the seventeenth century. The modifications in the central square and its surroundings have wiped out the few vestiges of the colonial period, although the locals believe that some of the houses belonged to the conquerors. The temple tells us a lot about the origins of the Real de Minas de los Tajos del Nervión de Pánuco, since it was dedicated to the Biscay Virgin of the Rosary or of the Victory, which refers to the Christian victory at the Battle of Lepanto against the Turks in 1571.

Pánuco was the place where on All Saints Day, November 1rst, 1548, Cristóbal de Oñate among others discovered the silver veins which made Zacatecas famous due to its high productivity for smelting and amalgamation during the colonial period.

Since the most important mines that were discovered were located several miles away—"one and two leagues"—from Zacatecas, the mining town of Pánuco was founded so that the mine owners would not have to travel between the small mining towns and the city. In fact, Pánuco and Zacatecas constituted a political unit integrated into a single judicial and administrative district (Enciso Contreras 1994; Mota y Escobar 1940).

The aforementioned Cristobal de Oñate was one of the rich miners who settled in Pánuco, where he had 13 grinding and refining mills, 101 slave houses, and a two-story residence. He also constructed within his property a church, and he covered the cost of supporting a priest so that all the miners could attend mass (Sescosse Lejeune 1985). In 1552, his wife, Catalina de Salazar, gave birth to twins. One of them was named after his father; and the second one, Juan de Oñate (Etulain 1999), became famous due to his unsuccessful search in 1598 for the fabled cities of gold (Cibola) and the beginning of the colonization of New Mexico; these adventures were financed with the silver extracted in Pánuco.

By 1562, in the Zacatecan mining district, there were 35 amalgamation mines and about the same number of smelting mines exploiting veins like the one in Pánuco (Langue 1993). The operations were definitely profitable for people such as the Spaniard Gregorio Quintana, who in 1575 was a mine manager of one of the Oñates' mines that was worth 200,000 pesos, and earned an annual salary of 1000 pesos, while the foreman at his orders made 200 pesos. By that time he had bought a hacienda which was worth 5000 pesos (Otte 1985).

We must point out that in 1598, the more than 1000 individuals who worked in the Zacatecan mines created a colorful ethnic mosaic comprising 11% black slaves, and more than 88% free Indians (Martínez López Cano 2001).

In the sixteenth century, the wholesale merchants of the Zacatecan mines had no direct negotiations with Castile (Enciso Contreras 1994) due to the monopoly of the merchants in the capital of New Spain. Consequently, it was common to trade consumer goods from the motherland, China, and Mexico City to the mining towns in order to exchange them for silver (Martínez López Cano 2001). In Pánuco, as well as in the city of Zacatecas, there was a street market; there were also a large number of supply stores, although trading was less significant in Pánuco than in the jurisdiction (Enciso Contreras 1994).

Until the late seventeenth century mining in the Sierra de la Bufa and the area around Zacatecas such as Vetagrande surpassed the metal yields of Pánuco, with 29 million pesos paid to the Crown in 1643 (Brading 1970; Mechan 1927).

From 1620 to 1630 there was a prosperous period in the Zacatecan silver production which was not equaled again until the early eighteenth century, but it was followed by a depression sharpened by tragedies such as the flooding of the Vetagrande mine from 1619 to 1620; epidemics that decimated black workers, mulattoes, and Indians; and the depopulation caused by the migration to the Nueva Vizcaya Parral mining district (Alberro 1985). By the eighteenth century, from 1740 to 1763, there was also decline in the Zacatecan mining sector, followed by a recovery in the last third of the eighteenth century, which was the golden age for the companies or "mining capitalists" (Lange 1991).

By the mid-seventeenth century, despite Pánuco's prosperous economy and the fact that its discoverers were among the wealthiest men living in the Spanish possessions in the Americas, the mismanagement of their fortunes as well as their unsuccessful investments in other enterprises, conquests, and the wars they took part in ruined them. Like Juan de Oñate, who was New Mexico's conqueror, their descendants inherited illustrious names but more debts than capital.

According to a population and housing census that probably dates from the seventeenth century, the town of Pánuco was prosperous; and there were five churches, 72 residences, 235 slave houses, 27 grinding mills, 41 smelting mills, 14 amalgamation mills, 39 owners of mines and mills, two or three priests, two traders, three merchants, one blacksmith, one butcher, and one carpenter (Acosta López 2013: 7).

Frédérique Langue's (1991) stories of great and wealthy miners are more mythical than real. Pánuco's history shows that wealth rarely remained in its owner's hands; these men often financed other enterprises and thus squandered their fortunes and capital. Furthermore, due to the fluctuations in the quality and quantity of silver that was obtained, they could barely afford the mercury required for the smelting process and paying taxes to the Crown. Consequently, the Pánuco mines passed from one owner to another.

Bartolomé Bravo de Acuña, a descendant of the Oñates and Temiño de Bañuelos, who were Zacatecas' first conquerors, bought the Real de Pánuco mines by the mid-seventeenth century. He was succeeded by his son Juan Bravo de Medrano, who was a peacemaker in Colotlan and Sierra de Nayarit. He was also Lieutenant General of Nueva Galicia; and thanks to his success in mining, he became the first Zacatecan to buy a noble title, becoming the count of Santa Rosa in 1691; however, his son inherited his debts and flooded mines, and he was not able to keep the precarious family business, so his goods were auctioned after his death due to his insolvency (Rivera Bernardez 1883).

When the second Count of Santa Rosa died in 1706, notarial records listing his properties include the Pánuco smelters and amalgamation facilities (Archivo Histórico de Zacatecas, Fondo Poder Judicial, Serie Civil, Caja 5). At the hacienda, the chapel had a tower with three bells; inside there were two altars, but it had to be remodeled because the ceiling collapsed. Religious sculptures represented Our Lady of the Immaculate Conception, with a silver crown; St. John the Evangelist; St. John the Baptist; St. Bartholomew, with silver crown and two angels; Our Lord Jesus Praying in the Garden; and Jesus of Nazareth. Other elements included two large crucifixes with silver aureoles and other ornaments, and for the liturgy, objects in silver like a cruet, a paten, a chalice, a thurible, an incense boat, and small bells.

The house was in good condition and was presented to the new owner with all the accessories (doors, keys, etc.). It contained 40 canvas paintings of all sizes; a Mexican crucifix with a baldachin made of red damask; five oil paintings of landscapes and three portraits; , four wooden benches, a table, and a tablecloth; three Mexican-style desks; two baskets, two beds, a cedar chest, three tables, and one iron chest; a chair and a stool; and a wooden wardrobe.

On the other hand, the buildings at the smelter had roofs, walls, and doors with padlocks; and at a stable there were six mills stored inside. All the mills had four pitchforks, horse blankets, and blinkers. There were two stables with managers, stone-water tanks with plaster coating, and in front a water-wheel with four pillars and a water tank embedded in a wall to provide water through channels to the stables. There were also warehouses made of stone with plaster coating to store salt . The stone horizontal cog-wheel and shaft and the sieves required for the amalgamation process were also stored there.

The hacienda also had an amalgamation yard and two horse powered-treadmills, one close to the creek as well as a room to store mercury adjoining the yard and washing vats with wood channels and a water-wheel. The multiple iron and wood instruments required in the different phases of the amalgamation and smelting processes are also listed in the inventory. The list includes a female black slave; three adult and two infant mulattoes; a herd of 24 mules; 34 pack donkeys; harnesses, sacks, and ropes; and 300 mules and 82 horses used to power the mills.

Juan Alonso Díaz de la Campa, Knight of the order of Alcántara, bought this property and became the most important silver producer in Zacatecas between 1725 and 1750. He owned several mines as well as Pánuco's smelting facilities and used his own capital to lead an expedition first to Mazapil and then to the province of Texas. When he died his company was dismantled, and his smelters were sold. Then Manuel Flores Correa became the new owner of the mine of Nuestra Señora del Buen Suceso in Pánuco. By 1781 he had 55 workers, 5 Spaniards and 50 mixed-race individuals. Eventually he sold his smelters to the Vetagrande Company, which was formed in 1783 (e.g., Bakewell 1971; Brading 1975; Garner 1970; Langue 1987, 1988): the era of the private owners of mines gradually made way for shareholders and partners that formed companies.

In the second half of the nineteenth century several mines as well as the smelting facilities in Pánuco were sold to Mexicans; but during the late 1800s several foreign companies were in charge of mining. In this context, national companies such as

Negociación Minera Azogueros were overwhelmed by losses and taxes, and were forced to sell all their properties in 1893, including the Juárez mine in Pánuco (Gámez Rodríguez 2004).

In Panuco silver production gradually decreased from the late seventeenth century on due to the mineral's scarcity, although the poor exploitation of metal in Pánuco continued through the twentieth century.

Among the smelting facilities that the Bishop of Guadalajara, Alfonso de la Mota y Escobar (1940: 154–155) refers to in the early seventeenth century, four haciendas in Pánuco are listed, one with eight mills. Pánuco had a mild climate, good land where fruit trees were grown, and many water sources; however, the Bishop noticed that mining activities were not as intensive as before. The buildings are partly preserved but terribly affected by the extraction of mercury and stone since the 1940s, according to our informants. The facility has undergone few changes since it was declared common land in 1965 as an elementary school garden.

5.6 The Hacienda del Buen Suceso in Pánuco

The Hacienda del Buen Suceso in Pánuco evidences the development of mining headed by the Oñate family, with its fortunes and misfortunes; it was part of a major population center, with a labor pool and farming land that developed because of metal extraction.

Based on our surveys, the distribution of spaces and some architectural features part of activity areas and buildings with specific functions in mining can be distinguished on the surface (Fig. 5.4). The chapel's plan is defined, including its access and apse, with its tower attached to the front and a side ramp, and there are a few steps in good condition at the bottom. One of the vats used to separate the amalgamated ore from waste rock after it had aged in the sun is intact, and some of its internal walls have been recently cemented in order to take advantage of the water that accumulates; so most of the channels that took the fluid from the aqueduct, whose beginning is unknown, have been blocked up.

The smelting and amalgamation yard, which is next to the vats, adjoins a large area where there are several retaining walls that according to the archaeological materials on the surface and the regularity of the alignments of the stone foundations formed platforms for rooms, which must have been some of the rooms with different functions listed in the second Count of Santa Rosa's inventories.

The main house, which has been severely plundered in order to recover building materials and as a result of treasure hunting, is located in the north part of the complex; and to the east toward the stream, there are broad segments of the smelter's battlemented rampart still standing (Fig. 5.5); this wall probably dates to the nineteenth century, considering it was not mentioned in the inventories from the eighteenth century. This channel must have been used for discarding tailings, which overstock the eastern margin of the creek, looking like gray mounds since no vegetation grows because of the abundance of toxic substances such as mercury and arsenic, by-products of the amalgamation process.

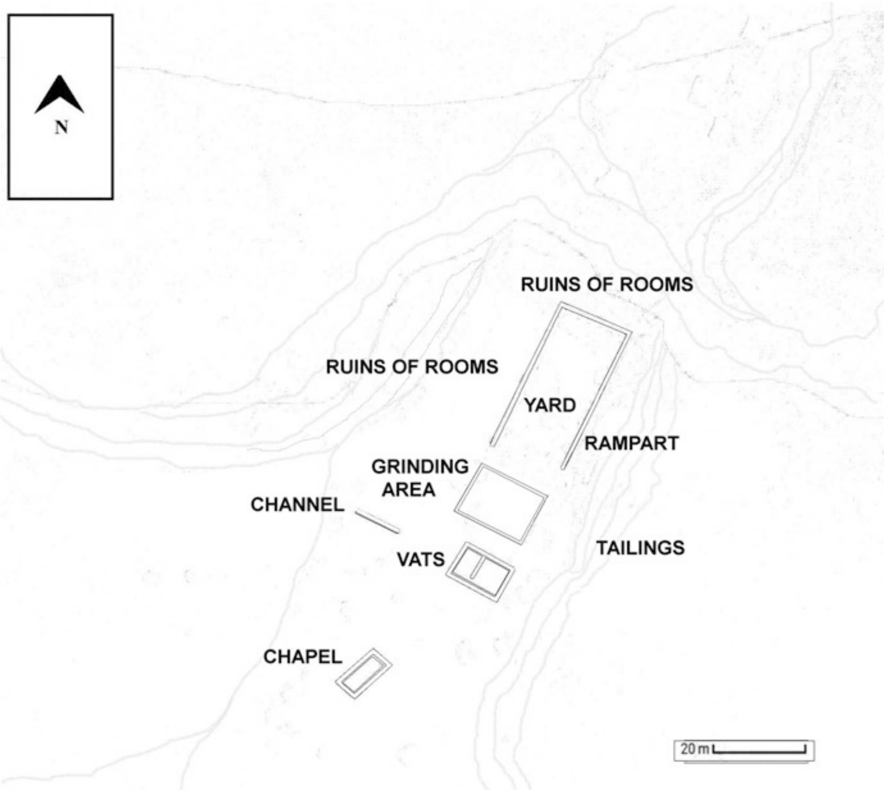

Fig. 5.4 Ruins of the Hacienda de Pánuco

The archaeological materials that clearly show the smelter's opulence include fine pieces of Chinese porcelain of the Ming and Ching dynasties, some fragments of fine burnished pottery from Guadalajara, colonial period majolica from Puebla and Republican period majolica from Guanajuato and Aguascalientes, nineteenth-century British transfer-printed whitewares, a few French porcelain sherds from the nineteenth century, as well as monochrome and black-on-orange glazed pottery dating from the seventeenth to the twentieth century.

5.7 Conclusions

In New Spain, the new conquests to the north and west employing natives as part of the Spanish armies working as porters, servants, or slaves, resulted in a movement of different indigenous ethnic groups that originated in the central valleys and ended with their settling elsewhere, often as members of the lower classes. Together with the Spanish settlers, they introduced Old World crops, agricultural techniques such

Fig. 5.5 Hacienda de Pánuco, ruins of amalgamation yard and section of the battlemented rampart

as the use of the plough, livestock, and strategies for exploiting natural resources not suitable for dryer climates and thin soils, contributing to land degradation and desertification.

Before the Spanish invasion, most of Mexico sustained high- or low-intensive agriculture, and the exploitation of forest resources was limited; hence, the human impact on the environment was not significant in the Mezquital Valley and Zacatecas. Except for a few zones, the landscape was green, almost lush, and water was not scarce; but the post-conquest introduction of domestic animals and overgrazing brought changes in the vegetation and an increase in xerophytic shrubs.

Moreover, large-scale mining caused great damage to forests, often leading to the deforestation of mining regions (e.g., Bakewell 1971; Elliot et al. 2010; Melville 1994).

Because of the method used to process precious metals from the ores, toxic wastes formed tailings, and over time these mine dumps became an environmental liability since toxic elements impacted on soils and sediments and saturated the water table and groundwater (e.g., Gutiérrez Ruiz et al. 2007; Yarto Ramírez et al. 2004).

All over New Spain, miners made fortunes extracting silver while employing methods that polluted the environment; and the Otomí charcoal-makers, found a way to earn some money with their craft, ravaged forest resources intact before the Spanish conquest.

Silver mining in Mexico and South America fueled the global economy, the development of capitalism in Europe, and a new system of monetary economy in Asia where silver coined in New Spain became the most important currency in late imperial China. But the legacy of silver exploitation is complex and goes beyond economics. As a consequence of human agency in metal mining and metal smelting, toxins remain in soils, sediments, and aquatic systems. Since post-conquest times and for centuries, chemical pollutants and metals such as lead, mercury, and arsenic have contaminated thousands of square kilometers of arable and grazing lands all over Mexico. Moreover, mining degraded large areas of forest resources, leading to the deforestation and soil erosion exacerbated by over-intensive grazing of cattle, sheep, and goats in central and northern Mexico. Studnicki-Gizbert and Schecter (2010: 111) explain, “Deforestation and the associated development of a colonial agroecology profoundly transformed existing ecologies and the human communities that interacted with them.”

In Mexico, recently constitutional amendments and the energy reforms of 2013 implemented by the most corrupt government the country has had in years resulted in lax environmental regulations, and permits to exploit metals have been continuously issued. Hence, powerful foreign companies—including Canadian enterprises (e.g., Olvera 2017)—have been taking advantage of this new scenario. While peasants can barely make a living and many try to migrate north of the border, these companies continue to deplete natural resources, polluting soils and the water table.

Colonialism has many forms and variations, and from the Spanish invasion until today a once mighty, rich area has been continuously exploited over and over. As a result, even today most of the nation’s wealth ends up in the hands of those who do not care for the Mexicans’ well-being.

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References

Acosta López, O. (2013). *Arquitectura mexicana del siglo XVI. La época de la colonia y minería en Pánuco* (Master’s thesis). Zacatecas: Instituto Tecnológico de Zacatecas.

Acuña, R. (Ed.). (1985). *Relaciones Geográficas del siglo XVI: México. Tomo I*. México: Universidad Nacional Autónoma de México.

Acuna Soto, R., Stahle D. W., Cleaveland M. K., & Therrell M. D. (2002). Megadrought and megadeath in 16th century Mexico. *Emerging Infectious Diseases, 8*(2), 360–362. https://doi.org/10.3201/eid0804.010175

Alberro, S. (1985). Zacatecas, zona frontera, según los documentos inquisitoriales, siglos XVI y XVII. *Estudios de Historia Novohispana, 8*, 139–174.

Argueta Spínola, C. (2006). *Descripción y análisis de dos métodos de producción de carbón vegetal en el estado de Tamaulipas* (BA thesis). México: Universidad Autónoma de Chapingo.

Ayala, M. L. (2007). Desmonte y agricultura en Nueva España. In A. Fábregas Puig, M. A. Nájera Espinoza, & J. Alfredo Ortiz Garza (Eds.), *Diversidad cultural y sobrevivencia. La frontera chichimeca, una visión desde el siglo XXI* (pp. 245–260). México: Universidad de Guadalajara, Universidad Autónoma de Zacatecas, Universidad Autónoma de Aguascalientes, Universidad Intercultural de Chiapas, El Colegio de San Luis, El Colegio de Jalisco, Universidad Autónoma de Coahuila.

Azcona Pastor, J. (2004). *Possible paradises: Basque emigration to Latin America*. Reno: University of Nevada Press.

Bakewell, P. J. (1971). *Silver mining in colonial Mexico, Zacatecas 1546–1700*. Cambridge: Cambridge University Press.

Bakewell, P. J. (1984). Mining in colonial Spanish America. In L. Bethell (Ed.), *The Cambridge History of Latin America*, *Colonial Latin America* (Vol. II, pp. 105–152). Cambridge: Cambridge University Press.

Bernstein, M. D. (1964). *The Mexican mining industry 1890–1950*. New York: State University of New York.

Biringucci, V. (1540). *De la pirotechnia: Libri X. dove ampiamente si tratta non solo di ogni sorte and diversita di miniere, ma anchora quanto si ricerca intorno à la prattica di quelle cose di quel che si appartiene à l'arte de la fusione ouer gitto de metalli come d'ogni altra cosa simile à questa*. Italy, Veneto.

Bloom, L. B. (1939). Oñate's exoneration. *New Mexico Historical Review, 12*(2), 75–191.

Brading, D. (1970). Mexican silver mining in the eighteenth century: The revival of Zacatecas. *Hispanic American Historical Review, 50*(4), 665–681.

Brading, D. (1975). *Mineros y comerciantes en el México borbónico (1763–1810)*. México: Fondo de Cultura Económica.

de la Mota Padilla, M. (1973 [1742]). *Historia del Reino de Nueva Galicia en la América Septentrional*. México: Universidad de Guadalajara, Instituto Jaliciense de Antropología e Historia, Instituto Nacional de Antropología e Historia.

de la Mota y Escobar, A. (1940 [1605]). *Descripción Geográfica de los Reinos de Nueva Galicia, Nueva Vizcaya y Nuevo León*. Editorial Pedro Robredo: México.

de Mendizábal, M. O. (1941). Los minerales de Pachuca y Real del Monte en la época colonial. *El Trimestre Económico, 8*, 253–309.

de Rivera Bernardez, J. (1883 [1732]). *Descripción breve de la muy noble y leal ciudad de Zacatecas*. Zacatecas: Imprenta de la Penitenciaría.

Echavarría Cháirez, F. G., Medina, G. R., Gutiérrez, L. A., & Serna, P. (2004). Identificación de áreas susceptibles de reconversión de suelos agrícolas hacia agostadero y su conservación en el Ejido Pánuco, Zacatecas. (Identification of areas to reconvert from agricultural uses to rangelands and its conservation in the ejido Panuco, Zacatecas). *Técnica Pecuaria, 42*(1), 39–53.

Elliott, M., Fisher, C. T., Nelson, B. A., Molina Garza, R. S., Collins, S. K., & Pearsall, D. M. (2010). Climate, agriculture, and cycles of human occupation over the last 4000 yr in southern Zacatecas, Mexico. *Quaternary Research*, *74*, 26–35. https://doi.org/10.1016/j.yqres.2010.04.001

Enciso Contreras, J. (1994). Mercado de vino, mercaderes y fraude de la sisa en Zacatecas (1583–1584). *Estudios de Historia Novohispana, 14*, 9–37.

Etulain, R. W. (1999). *Portraits of Basques in the New World*. Reno: University of Nevada Press.

Fournier Garcia, P. (2007). *Los hñähñü del valle del mezquital: maguey, pulque y alfarería*. México: Escuela Nacional de Antropología e Historia, Instituto Nacional de Antropología e Historia.

Fournier Garcia, P., & Blackman, M. J. (2010). Recorridos a lo largo del Camino de la Plata: El Real de Minas de Pánuco y la Hacienda del Buen Suceso, Zacatecas. In P. Fournier Garcia & F. López Aguilar (Eds.), *Patrimonio, identidad y complejidad social* (pp. 309–340). México: Escuela Nacional de Antropología e Historia-Consejo Nacional para la Cultura y las Artes-Programa para el Mejoramiento del Profesorado.

Fournier Garcia, P., & López Aguilar, F. (2015). El camino real, la minería y la producción de carbón entre los otomíes del Valle del Mezquital. In L. C. Quiñones (Ed.), *Patrimonio e identidad en el Camino Real de Tierra Adentro y el camino nacional* (pp. 21–63). Durango/México: Universidad Juárez del Estado de Durango.

Fournier Garcia, P., & Mondragón, L. (2003). Haciendas, Ranches, and the Otomí Way of Life in the Mezquital Valley, Hidalgo, Mexico. *Ethnohistory, 50*(1), 47–68.

Gámez Rodríguez, M. (2004). *Propiedad y empresa minera en la Mesa centro-norte de México. Guanajuato, San Luis Potosí y Zacatecas, 1880–1910* (Doctoral dissertation). Bellaterra: Universidad Autónoma de Barcelona.

Garner, R. L. (1970). *Zacatecas 1750–1821: The Study of a Late Colonial City* (Doctoral dissertation). Ann Arbor: University of Michigan.

Gerhard, P. (1986). *Geografía histórica de la Nueva España, 1519–1821*. México: Universidad Nacional Autónoma de México.

Gibson, C. (1964). *The Aztecs under Spanish rule: A history of the Indians of the Valley of Mexico*. California: Stanford University Press.

González Dávila, F. (2003). *El rompimiento de El Bajío: la transformación de un espacio chichimeca en señorío español 1540–1560* (BA thesis). México: Facultad de Filosofía y Letras, Universidad Nacional Autónoma de México.

Gruen, L. (2001). Technology. In D. Jamieson (Ed.), *A companion to environmental philosophy* (pp. 439–448). Malden/Oxford, UK: Blackwell Publishers. https://doi.org/10.1002/9780470751664

Guerrero, S. (2016). The history of silver refining in New Spain, 16c to 18c: Back to the basics. *History and Technology, 32*(1), 2–32. https://doi.org/10.1080/07341512.2016.1191864

Gutiérrez Ruiz, M., Romero, F. M., & González-Hernández, G. (2007). Suelos y sedimentos afectados por la dispersion de jales inactivos de sulfuros metálicos en la zona minera de Santa Bárbara, Chihuahua, México. *Revista Mexicana de Ciencias Geológicas, 4*(2), 170–184.

Lacueva Muñoz, J. J. (2010). *La Plata Del Rey y de Sus Vasallos: Minería y Metalurgia en México (Siglos XVI y XVII)*. España: Secretariado de Publicaciones de la Universidad de Sevilla.

Langue, F. (1987). Del minero rico a la nobleza: El papel de la frontera zacatecana en la formación de una élite económica y social. *Anuario de Estudios Americanos, 44*, 173–193.

Langue, F. (1988). Les grands propriétaires terriens de Zacatecas (Mexique) au XVIIIe siècle: permanence et évolution d'un modèle aristocratique. In B. Lavallé (Ed.), *Structures et cultures des sociétés hispaniques. Au-delà du modèle socio-économique, Actas del Coloquio Homenaje al Profesor François Chevalier* (pp. 279–294). Bordeaux: Maison des Pays Ibériques/C.N.R.S.

Langue, F. (1991). Mineros y poder en Nueva España. El caso de Zacatecas en vísperas de la Independencia. *Revista de Indias, 51*(192), 327–341.

Langue, F. (1993). El arbitrismo en el gremio minero novohispano o la representación de J. de la. Borda y J. L. Lazaga (1767) (Documentos). *Anuario de Estudios Americanos, 50*(1), 269–302.

Maldonado, B. E. (2006). *Preindustrial Copper Production at the Archaeological Zone of Itziparátzico, a Tarascan Location in Michoacán, México* (Doctoral dissertation). Pennsylvania: The Pennsylvania State University.

Martínez López-Cano, M. d. P. (2001). *La génesis del crédito colonial: Ciudad de México, siglo XVI*. México: Universidad Nacional Autónoma de México.

Mechan, J. L. (1927). The Real de Minas as a Political Institution. A Study of a Frontier Institution in Spanish Colonial America. *The Hispanic American Historical Review, 7*(1), 45–83.

Mechan, J. L. (2005 [1927]). *Francisco de Ibarra y la Nueva Vizcaya*. (J. de la C. Pacheco, Intr.). México: Gobierno del Estado de Chihuahua, Universidad Juárez del Estado de Durango.

Melville, E. G. K. (1994). *A plague of sheep. Environmental consequences of the conquest of Mexico*. Cambridge: Cambridge University Press.
Molina del Villar, A., & Navarrete Gómez, D. (2007). *El padrón de comulgantes del arzobispo Francisco Antonio Lorenzana 1768–1769*. México: Centro de Investigaciones y Estudios Superiores en Antropología Social.
Olvera, D. (2017, January 30). Canadá se presume como "amigo" del mundo, ambientalista; pero en México… ha enseñado el cobre. *SinEmbargo*. Retrieved from http://www.sinembargo.mx/30-01-2017/3140858
Ongley, L. K., Sherman, L., Armienta, A., Concilio, A., & Ferguson Salinas, C. (2007). Arsenic in the soils of Zimapán, Mexico. *Environmental Pollution, 145*, 793–799. https://doi.org/10.1016/j.envpol.2006.05.014
Otte, E. (1985). Los pobladores europeos y los problemas del Nuevo Mundo. *Estudios de Historia Novohispana, 8*, 11–50.
Ponce, B. F. (1985). *Caldera development and economic mineralization in the Zacatecas mining. District, Zacatecas, Mexico* (Master' thesis). Texas: The University of Texas at El Paso.
Porras Muñoz, G. (1968). Diego de Ibarra y la Nueva España. *Estudios de Historia Novohispana, 2*, 49–78.
Powell, P. W. (1984 [1975]). *La guerra chichimeca (1550–1600)*. (J.J. Utrilla, Trad.). México: Secretaría de Educación Pública, Fondo de Cultura Económica.
Probert, A. (1987). *En pos de la plata. Episodios mineros en la historia hidalguense*. (L. Vera Graciano, Trad.). México, Pachuca, Hidalgo: Compañía Real del Monte y Pachuca, S.A.-SEMIP.
San Martín, J. (1989). Francisco de Ibarra, conquistador de Nueva Vizcaya y fundador de la ciudad de Durango en México. *Euskera, 34*, 299–304.
Sescosse Lejeune, F. (1985). *Temas Zacatecanos*. Zacatecas: Sociedad Amigos de Zacatecas.
Sonneschmid, F. (1983 [1825]). *Tratado de la Amalgamación de Nueva España*. México: Sociedad de Exalumnos de la Facultad de Ingeniería, Universidad Nacional Autónoma de México.
Studnicki-Gizbert, D., & Schecter, D. (2010). The environmental dynamics of a colonial fuel-rush: Silver mining and deforestation in New Spain, 1522 to 1810. *Environmental History, 15*, 94–119. https://doi.org/10.1093/envhis/emq007
Tamayo, J. L. (1943). La minería de Nueva España en 1794. *El Trimestre Económico, 10*, 287–319.
Valerio Ortega, M. (1902). The patio process for amalgamation of silver-ores. *Transactions of The American Institute of Mining Engineers, 32*, 276–285.
Vergara Hernández, A. (2010). *Las pinturas del templo de Ixmiquilpan ¿Evangelización, reivindicación indígena o propaganda de guerra?* Pachuca, México: Universidad Autónoma del Estado de Hidalgo.
Wolf, E. R., & Mintz, S. (1957). Haciendas and plantations in Middle America and the Antilles. *Social and Economic Studies, 6*, 380–411.
Yarto Ramírez, M., Gavilán García, A., & Castro Díaz, J. (2004). La contaminación por mercurio en México. *Gaceta Ecológica, 4*, 21–34.
Zumalde, I. (1998). *Los Oñate en México y Nuevo México*. Oñati, España: Ayuntamiento de Oñati, Ayuntamiento de Zacatecas.

Chapter 6
Towards an Archaeology of Extensive Pastoralism in the Great Artesian Basin in Australia

Tim Murray

Abstract In this essay I briefly outline the essence of a new interdisciplinary research project exploring the historical archaeology of extensive pastoralism in Australia, with a particular focus on the Western Division of New South Wales. Core elements of the project span conventional ecological history (especially the impact of sheep and cattle grazing on the rangelands of the region), as well as the history of wool as a global commodity, the impact of the dispossession of indigenous people by European settlers, and the impact of new technologies such as fencing, railways, and particularly drilling for artesian water. The research project thus considers many elements of a more general inquiry into the ecological and economic impacts of the creation of both national and imperial entities (and identities) during the nineteenth and early-twentieth centuries around the globe.

6.1 Introduction

In this essay I briefly outline the essence of a new interdisciplinary research project exploring the historical archaeology of extensive pastoralism in Australia, with a particular focus on the Western Division of New South Wales. Core elements of the project span conventional ecological history (especially the impact of sheep and cattle grazing on the rangelands of the region), as well as the history of wool as a global commodity, the impact of the dispossession of indigenous people by European settlers, and the impact of new technologies such as fencing, railways, and particularly drilling for artesian water. The research project thus considers many elements of a more general inquiry into the ecological and economic impacts of the creation of both national and imperial entities (and identities) during the nineteenth and early twentieth centuries around the globe.

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6.2 Background

> 'Whenever the historian's sources go "beyond words", and this is the case when you adopt a transnational perspective, archaeology is a card to be counted on' (Saunier 2013: 128).

The world of the nineteenth century was the outcome of processes that had their roots in the first 300 years of European expansion, as well as forces such as industrialisation, large-scale migration, and heightened forms of colonialism that came to the fore after those years. The overarching aim of my current research is to link the historical archaeology of the earlier Atlantic world (e.g., Elliot 2006) with the archaeologies of the Indian Ocean (e.g., Parthasarathi and Riello 2014) and Pacific worlds by tracing historical continuities and discontinuities over the past 500 years. This research is founded on an interdisciplinary collaboration with economic, ecological, social, and cultural history and explicitly acknowledges that previous historical research into urbanization, migration, convictism, pastoralism, ecological transformation, and technology transfer, in Australia and elsewhere, is fundamental to the conduct of archaeological research and the analysis of material culture in these contexts (Blainey 1966; Butlin 1994; Contreras 2017; Crosby 2004; Davidson 1994; Frost 2014; Jupp 2007; Letnic 2007; Linge 1979; Robin 2009; Ville 2000).

My research into the archaeology of wool in Australia foregrounds a transnational theoretical agendum and focuses on developing an understanding of the development of the Australian wool industry as a subset of a more general inquiry into archaeologies of global commodities, the archaeology of indigenous–settler interactions, the archaeology of pastoralism in the Great Artesian Basin of Australia, and ecological transformation and technology transfer that resulted from European settlement of arid Australia.

Historical archaeology has always been concerned with transnational matters, particularly the great flows of people, material culture, technology, and, of course, capital, all of which left Europe for the peripheries in the late sixteenth century and have been washing back and forth ever since (e.g., Hall 2000; Leone and Potter 1999; Orser 1996; Williams and Voss 2008).

Over the past three centuries, people around the globe have been participating in what has been called the modern world system—comprising not only flows of people, capital, and trade, but ideas, aspirations, and, perhaps more concretely, material culture as various as locomotives and tea cups.

It is a commonplace observation that the pace and intensity of interaction between people scattered all over the globe rapidly increased during this time, and that the pace and intensity of social and cultural change has matched this. These are the centuries of mass production and consumption, and of the increasing industrialisation of all aspects of life—changes that have been understood, especially in recent times, as having the potential to create a global social and cultural uniformity (e.g., Appadurai 1996; Berger and Huntingdon 2002; Glick Schiller et al. 1992). This uniformity might have crushed the identities of those societies and cultures that, for whatever reason, have lost the capacity to generate and sustain distinctive identities. In the past decade or so these have become highly sensitive matters, because people have been forced to contemplate the consequences of global markets and their local impacts. Equally sensitive are the challenges societies face from the movements of people—no matter whether they are referred to as economic refugees, asylum-seekers, or illegals—and from flows of culture, both to and from the countries of the West and within the West itself (see e.g., Mullins 2008).

This global perspective has powered fundamental research into the archaeology of the 'Atlantic world' since the beginning of European exploration of the New World and West Africa, and has gained particular force in the archaeology of slavery (Hall 2000; Orser 1996, 2010), capitalism (Croucher and Weiss 2011; Leone and Potter 1999), and, since the mid-1990s, the archaeology of indigenous–settler interactions in North and South America (Murray 1992, 1996; Silliman 2005). Notwithstanding this overarching context of practice, much historical archaeology still rests on small-scale, single-site research that presents challenges for global comparisons between sites of a similar antiquity and broadly similar historical contexts. This is especially the case in Australia: here, with the exception of recent work in the archaeology of the modern city (e.g., Murray 2003) and explorations in maritime archaeology (e.g., Stanniforth and Nash 2006), practitioners have tended to dispense with the original broad, comparative vision of the founders of historical archaeology (Birmingham and Jeans 1983).

6.3 Transnational Archaeologies

Given its genesis as the archaeology of the European colonization of North America, historical archaeology at its core has sought to address two major issues. The first is the need to build concepts that demonstrate the importance of archaeological data (and the material culture that lies at its core) to the writing of social and economic history. The second is the need to articulate local, regional, national, and global scales in interpretation and analysis. Historical archaeology has the demonstrated capacity to track material culture in circulation from the point of production to the many points of consumption, revealing the connections and different sense of duration that have frequently gone unremarked by document-based historians. This circulation of material culture in archaeological contexts has long encouraged an understanding that a multiscalar approach to problem selection and analysis should be a major goal for the discipline (e.g., Orser 2010). The interplay of global and local frames of reference, and the challenges faced when both archaeologists and historians seek to integrate archaeological and written documentary information, have driven historical archaeologist to look much more closely at core processes such as migration, colonization, and ethnogenesis (particularly in societies where 'hybrid', creole, or 'subaltern' societies have been created through colonialism). The current research program will target key issues and contexts for modern scholars and readers: indigenous–settler relations; the transfer of agricultural, manufacturing, and managerial technologies; the movements of people and material culture; and the transformation of indigenous ecologies as a result of colonisation.

Over the past 40 years, historical archaeologists have sought to contribute to a broader understanding of how new societies were created from old (either emigrant or indigenous), and of how class, ethnicity, and gender have played out in the nations created out of imperialism and colonialism. However, while these are to an extent local and unique phenomena, they have taken place within the broader context of global modernity. Significant flows of capital, technology, consumer goods, and people were encouraged both within and outside the British Empire, especially into the United States. Between 1815 and 1914, a total of 22.6 million people left Britain for settlements and colonies spread out across the world, as did hundreds of millions of pounds worth of capital that was invested in railways, ports, cities, ships, agricultural and pastoral enterprises, and the building of modern infrastructure such as courts, schools, and universities.

This was a century of astounding global mobility. Research into the broader contexts of the archaeology of wool in Australia program explores some of the archaeological contexts within which settler colonies, such as those in Australia, became established and then transformed into nations, during a period of intensifying globalisation. However, as I remarked in my edited book *The Archaeology of Contact in Settler Societies* (Murray 2004), exploring the archaeology of nation-building during this period, in the early twenty-first century, largely subverts the pre-eminence of the narratives that have told the national story by uncovering the 'hidden histories' of the marginalised and oppressed. These historical archaeologies of transformation, diaspora, and globalisation are also about frontiers, blurred boundaries, the refashioning of ethnicities and identities, and the survival of core elements of indigenous ethnicities (Croucher and Weiss 2011; Parker and Rodseth 2006). The political context of transnational historical archaeologies is undeniable and pervasive, since postcolonial societies simultaneously celebrate diversity and cultural and social possibilities from an extraordinarily eclectic sampling of global cultural capital, while seeking to retain identities that have created the cohesion of nations.

The core of the current research program will link the analysis of archaeological data, material culture, and historical documents to a close examination of life in the Western Division of New South Wales, Australia, in the nineteenth and twentieth centuries. This program will continue to explore issues of scale, particularly the interaction of the local and the global (Murray and Crook 2005; Orser 2010). This continues to be one of the most deeply contested aspects of the archaeology of the modern world, both in sixteenth- to eighteenth-century contexts as well as those of the nineteenth and twentieth centuries. Indeed, significant reexaminations of the already highly disputed role of migration as an explanation for culture change in archaeology have reignited debates about archaeological characterisations of the processes of social and cultural change resulting from the mobility of people and material culture, and the creation of the colonial and postcolonial worlds. These debates centre on how an increasingly globalised and homogenous material culture could be interpreted by its consumers in culturally heterogeneous ways across the world. This has led to a focus on the complexities of material culture as a marker of relationships and identities (some linked to ethnicities and others not). Yet scale can be approached as a way of gaining a clearer picture of archaeological phenomena as they appear at the level of the household, the community, the region, or even the globe.

6.4 The Archaeology of Wool in Australia

Ongoing research adds significantly to our understanding of the material culture of wool production and the social history of large-scale sheep grazing. It will achieve this through the documentation of the physical infrastructure, such as buildings, fences, yards, bores, and tanks found at those existing documentation of important sheep stations held in state and federal heritage registers, allowing a more extensive survey of sites spanning the entire history of the Australian wool industry. Further intensive recording will take place at Toorale Station on the Darling River near Louth, NSW, in preparation for excavations that will be undertaken over the next five years, and will link with earlier archaeological research at Kinchega Station further down the Darling River (Allison 2003), and on pastoral properties elsewhere in the Great Artesian Basin (e.g., Godwin and L'Oste-Brown 2012). Research at Toorale, which had a long and diverse history (Jack 2008), exemplifies the creative tensions between local and global perspectives on historical archaeology, while adding much to the heritage of the nation; at the same time, the project acknowledges the power of nostalgia for a 'lost world' when Australia was thought to have ridden on the sheep's back (Bean 1910). Linking global to local in the archaeology of wool in Australia directly connects material culture (particularly technology) with less tangible forces such as the global price of wool, the cost of capital, the development of managerial technologies that supported pastoral activities, frequently on a massive scale, and the development of transportation technologies. At places such as Toorale these tangible and intangible elements coalesce in the occupation history of the site and the material culture that remains abandoned in a landscape shaped by the often catastrophic interactions of nature and the European occupants.

Given the density of activity present on the site it is imperative that we also recognise that these were and remain intense indigenous landscapes as well. My research into the historical archaeology of Aboriginal Australia interacting with the research of others has set out a clear methodological and theoretical agenda for those aspects of the archaeology of wool in Australia, where the lives and destinies of pastoralists and Aboriginal people became so closely entwined. The broader concerns of that project, particularly the focus on 'commodity histories' that link material culture with documentary history, will focus on the material culture of wool production and distribution, significantly expanding the successful approach taken by researchers such as Giorgio Riello to the history of cotton, particularly the focus on the interrelationships between resources (the breeding of sheep in Australia), exchange (transport and trade) and production and consumption (technologies, organisations, institutions, and the 'culture' of pastoral Australia) (e.g., Riello 2013).

'Commodity histories' lie at the core of the transnational historical agendum, given that the creation of world markets in commodities such as wool, cotton, coffee, tea, and sugar spawned production systems as various as plantations and large-scale grazing of sheep and cattle (e.g., Riello 2013). Notwithstanding this transnational focus, the history of wool in Australia has been the subject of intense historical research (Butlin 1962a, b; Barnard 1962; Davidson 1994; Hancock 1972; Hume 1962) that clearly acknowledges the shifting fortunes of wool production and its significant impact on Indigenous communities of inland Australia and (perhaps just as great) its impact on rangeland ecologies (Blake and Cook 2006; Bonyhady 2000; Griffiths and Robin 1997; Robin 2007; Robin et al. 2010). Yet it is widely acknowledged that the social history and social archaeology of wool in Australia has not been nearly so comprehensively researched (Merritt 1998; Mitchell 1998), although the publications of historians such as Alan Mayne on life in the bush), and the indigenous historical archaeologies of Harrison (2004), Murray (1992, 1996), and Paterson (2005, 2010), have added valuable perspectives. The Australian Agricultural Company has received significant archaeological attention (Bairstow 2003). The other great nineteenth-century investment enterprise in wool growing, the Van Diemen's Land Company, has been the focus of smaller-scale archaeological research (Murray 2000).

The most significant recent discussion of the history of pastoralism in Australia (Pearson and Lennon 2010; see also Walker and Forrest 1995) speaks eloquently to a lack of knowledge about pastoral places of real heritage significance, and of the great diversity of material culture associated with wool production and distribution—other than homesteads and woolsheds that have for the most part gone undocumented. They conclude their book with a plea: 'It is hoped that the present study will help inform a re-assessment of the heritage values of our pastoral industry, and lead to a more encompassing representation of pastoral heritage places on both the National Heritage List and the state and territory heritage registers' (p. 180).

6.5 The Settlement of the Western Division of New South Wales

The Western Division of New South Wales (Fig. 6.1) comprises over 42% of the total land area of the state; the vast majority of its 32.5 million hectares are owned by the Crown, and administered under the Western Lands Act 1901. European settlement, primarily by sheep pastoralists or 'squatters', began shortly after initial explorations by Mitchell and Sturt in the early 1840s, and sheep populations rapidly expanded out from reliable water sources such as the Darling River (see Gorman 2012) (Fig. 6.2). Conflict with and dispossession of the indigenous population rapidly followed, although significant numbers remained on their lands while acting as servants or stockmen in the pastoral industry (Fig. 6.3). This trend was to continue until the 1960s, when the requirement to pay indigenous workers a wage equal to those paid to non-Aboriginals led pastoralists to cease employment except for seasonal work and resulted in a significant number of indigenous people moving to local towns such as Bourke and Wilcannia. Nonetheless, connections to country clearly remained strong (see, e.g., Bates and Martin 2012).

Fig. 6.1 Map of the Western Division of New South Wales, Australia. (Map drawn by Wei Ming, Department of Archaeology and History, La Trobe University)

Fig. 6.2 Blade shearing of sheep, western NSW c.1870. (Photographer unknown; open source)

Fig. 6.3 Group of Aborigines at Dunlop Station. (Photographer Charles Bayliss 1886; public domain)

Currently about 31 million hectares are held by pastoralists under perpetual leasehold title from the Crown. This form of land tenure is fundamentally the result of the settlement history of the semi-arid rangelands that largely characterise the ecology of the area. The Western Division experiences very high summer temperatures, low and erratic rainfalls (with an average of some 200 mm per year), and very high evaporation rates. A further climatic constant is the regularity of severe drought, occurring on an average of one in every nine years. Since first settlement by pastoralists severe droughts have been experienced in 1845, 1864, 1895–1905, 1911–1917, 1928–1930, 1940–1946, 1965–1967, 1978–1985, 1993–1994, and 2001–2009.

This erratic climate has posed significant challenges to the state government, primarily because the region has (in the past) played a major role in building the economy of New South Wales (and Australia) economy through the production of wool. Condon (2002) and Barnes and Wise (2003) provide excellent summaries of the myriad of government inquiries and changes to management legislation that have occurred since 1901. Most important was the recognition (at the end of the nineteenth century) by the government, that unregulated pastoral enterprise in the Western Division was simply unsustainable. The major drought (caused by a

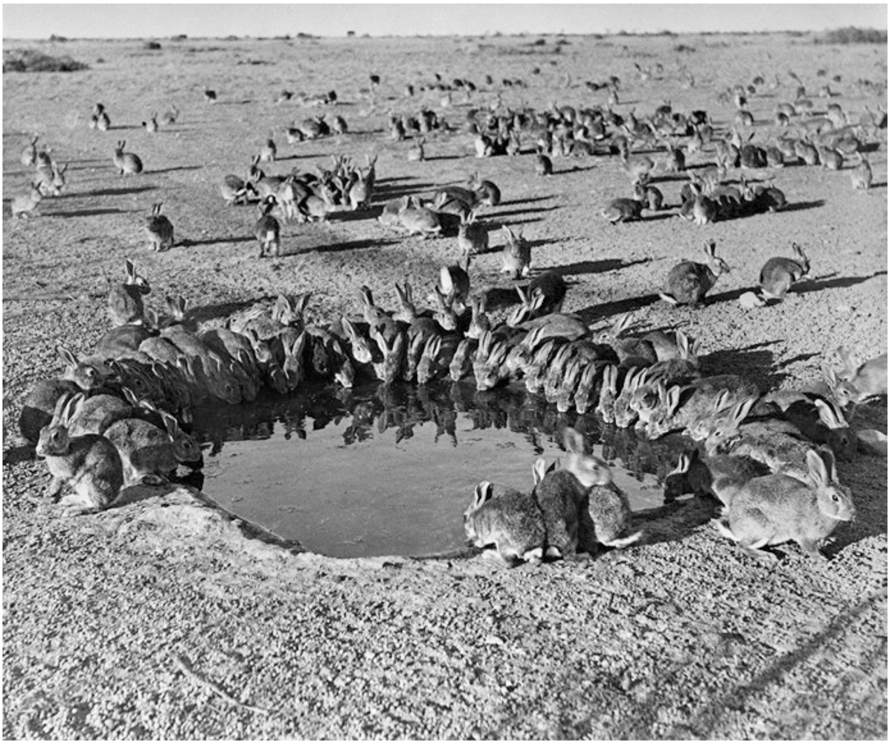

Fig. 6.4 Rabbits around a water trough. (Photographer M.W. Miles 1938; attributed to CSIRO Creative Commons)

combination of low rainfall and a major infestation of rabbits (Fig. 6.4) of the 1890 saw millions of sheep die of starvation and the government create some of the first legislation designed to achieve ecological stability. Critically, this legislation (which remains in force) has focused long-term attention on the consequences of pastoralism for the rangelands of the region—particularly on the degradation of the regions pastures (see especially McKeon et al. 2004). Since 1901 a vast literature has been built up exploring the consequences of extensive grazing on fragile rangelands. Both state and federal governments have committed significant funds to this research and while it is fair to say that we are some way from scientific consensus (see, e.g., Butzer and Helgren 2005 versus Gill 2005), there is little doubt that both governments and the pastoralists they manage are much better informed than in the past. Certainly the days of unregulated stocking are long gone, as the pastoralists themselves have come to recognise that the booms and busts of the past are no longer a viable economic model.

Similarly, the management of feral animals and their impact on the biomass of the region (both flora and fauna) has been required to deal with the infestation of imported animals such as wild cats and dogs, pigs, donkeys, goats, camels, foxes and particularly rabbits (see e.g., Coman 1999). The destruction wrought by rabbit plagues is well documented and governments have devoted significant research funds to creating biological controls that have helped control population growth. While rabbits and drought have had much to do with past busts, they alone have not been the cause. The long-tern decline of wool production in the region has also been the result of sliding wool prices since the end of the Korean War. The causes of this change in fortunes for wool (and for its producers) are well known and show few signs of reversal (at least in the short term) (Hume 1962; Ville and Withers 2015). The great boom in prices that occurred prior to the 1960s is unlikely to return. The collapse in the global price of wool (and indeed previous fluctuations) also had profound impacts on the pattern of investment in the regional wool industry. As we will see in the case of Toorale, grazing in these landscapes required significant acreages and the application of new technologies to allow sheep to be shorn and the fleeces prepared for market. It is no wonder that the first mechanised sheep shearing in the world occurred at the nearby station 'Dunlop', and that much ingenuity was involved in using scarce water resources to clean the fleeces (see Cumins 1989; Godwin and L'Oste Brown 2012; Pearson 1982; Pearson and Lennon 2010). It is also little wonder that much attention had been given to improving access to sub-artesian water since the 1860s, and to the use of wire fencing to manage stock since 1900. These are all important elements for explaining the massive expansion of pastoralism in the region that took place in the 50 years after first settlement. However, they were never as important as the development of technologies related to drilling for artesian water.

6.6 The Great Artesian Basin (GAB) and Its Consequences

The Great Artesian Basin (GAB) is the largest and deepest groundwater basin in the world, storing an estimated 8.7 billion mega-litres (or 64,900 cubic kilometres) of underground water, mostly beneath an arid ground surface. The amount of water is equivalent to three times the volume of the Great Lakes. That is enough to submerge all land on the planet a foot and a half deep. The basin covers 1.7 million square kilometres or around 22% of the Australian continent (Fig. 6.5), including most of Queensland (excluding the eastern parts), the southeast corner of the Northern Territory, the northeastern part of South Australia, and northern New South Wales. The GAB lies under parts of four major river catchment divisions: Lake Eyre, Murray-Darling, the northeast Coast, and the Gulf of Carpentaria, and provides the only reliable source of freshwater throughout much of arid and semi-arid inland Australia. Artesian water is not high in salt content; however, the high volume delivered to the surface and not used (wastage) adds about 150,000 tonnes of salt to the NSW landscape alone each year. This salt eventually ends up in the Murray-Darling drainage system, contributing to its salinity problems.

Waters of the GAB feed springs and wetlands that support a rich aquatic life, although many of these have been severely affected since European settlement. Plants, animals, and people have adapted to this landscape over many thousands of years with permanent waterholes (also referred to in the literature as springs, mound

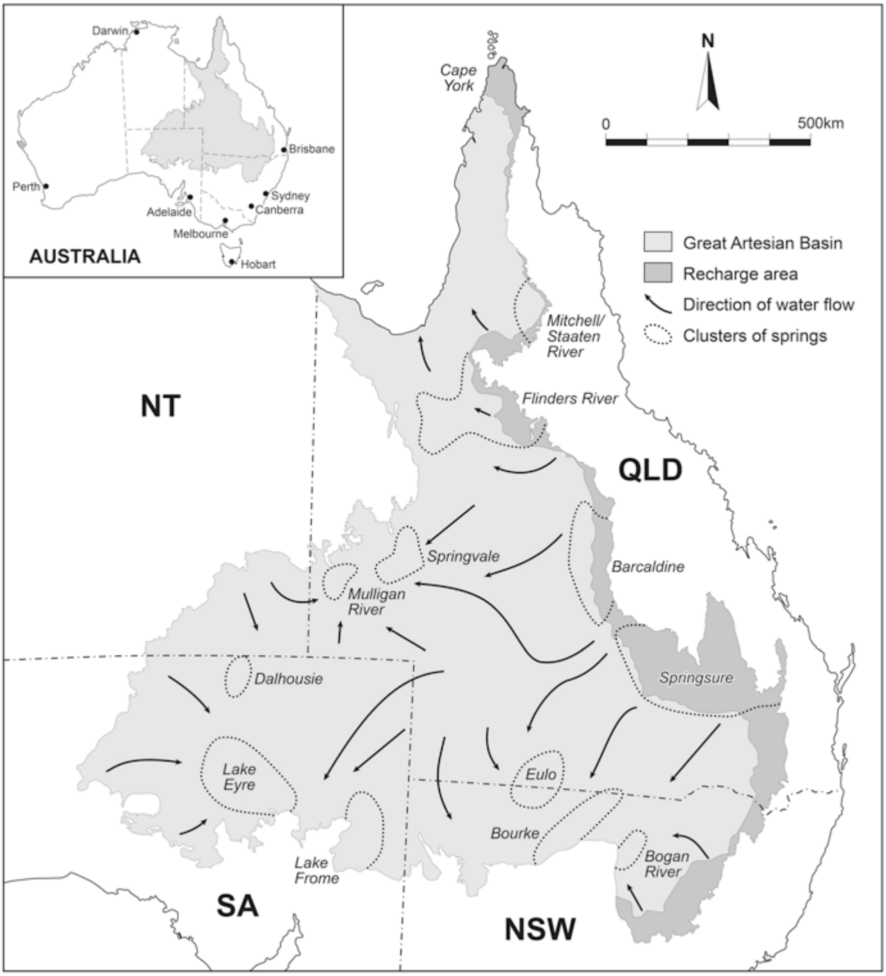

Fig. 6.5 The extent of the Great Artesian Basin in Central and Eastern Australia

springs, mud springs, water springs, and artesian springs) serving as semi-permanent oases or refuges in the arid and semi-arid zones during periods of prolonged drought and frequent fire events. Many springs have a distinctive mound, and these are often referred to as mound springs. These permanent springs have important biological values, with many wetland endemic species recorded. Spring wetlands come in a variety of forms, from desert ponds around Lake Eyre to tropical rainforest on Cape York Peninsula, each form supporting hundreds of specialised invertebrates, rare fish, and plant species. The presence of endemic species and large peat mounds shows that some springs are of considerable age.

Archaeological research provides evidence for long-term use by Aboriginal people of GAB springs, wetlands, and surrounding landscapes. In the late nineteenth century, the same springs, wetlands, and Aboriginal trade routes became essential resources used in the early development of European trade routes, early pastoralism and facilitated permanent settlement of inland or outback Australia. Today, the water resources provided by the GAB continue to be the lifeblood of many rural communities and associated pastoral/agricultural, mining, cultural and tourism activities. The total value of all production supported by GAB water was estimated in 2007 at $3.5 billion per year (www.environment.gov.au).

Archaeological and anthropological evidence as well as documented oral history and ethnohistory show that many GAB springs were once water sources that had strong cultural and spiritual values attached to them, as well as to the surrounding landscapes. Early European explorers, for example, John Oxley (1818) and Thomas Mitchell (1846), travelled in the GAB region along the Macquarie, Balonne, and Warrego river systems and noted the presence of springs and marshes as features on the landscape. Edward John Eyre (1939) and John McDouall Stuart (1859) relied on spring-fed water to journey into the interior of Australia. Early European use of GAB spring water includes the development of travel routes and the alignment of the Overland Telegraph. The narrow-gauge Ghan railway between Marree and Oodnadatta followed the line of GAB springs and early pastoral stations were also centred on spring locations.

The great transformation occurred in 1878 when a bore was sunk at 'Kallara' a station on the Darling River near Louth, which produced flowing water. Prior to that point pastoral settlement was generally confined along rivers such as the Darling, Warrego and Paroo (see Fig. 6.1). During the 1850s and 1860s settlement along the well-watered Darling River gradually expanded. Up to that point the management of surface water largely involved the excavation of ground tanks. Interest in drilling for artesian water rapidly expanded in the Western Division and reached its peak in the central west of Queensland. Flowing water was found at Back Creek east of Barcaldine in 1886 and at Thurrulgoonia near Cunnamulla in 1887. Pastoralists believed that this new, completely reliable source of water would effectively drought-proof their activities; and the population of sheep in the region exploded in the 1880s. The extensive system of travelling stock routes in western Queensland and New South Wales was thus made feasible by the discovery of the Great Artesian basin and the sinking of hundreds of government-funded bores to tap it. The complex relationship between stock movement, the artificial provision of water, and the development of the transport routes and settlement patterns is an important element of the overall inquiry.

6.7 Historical Archaeology in the GAB

Notwithstanding the reliance placed on sheep husbandry and the production of wool in the Australian economy, the technology associated with the early phase of the wool industry across the GAB has attracted relatively little interest from Australian historical archaeologists (Godwin and L'Oste-Brown 2012). Exceptions include

Pearson (1982), who reported on an excavation of the wool washing and scouring facility at Tibooburra in northern NSW. In central Queensland, the mechanical wool scour in Blackall (home of famous shearer Jacky Howe) has attracted research interest as well as funding for its conservation (Godwin and L'Oste-Brown 2012). The Blackall wool scour, along with a further 51 others, were established in the Central West Queensland region, operating as commercial operations (Cummins 1989).

The drilling of artesian bores in Australia was first made possible with American steam technology. The Wee Wattah bore on Kallara Station was dug during a drought, using a cable-tool rig in the bottom of a previously hand dug well, which intercepted seepage water from the Paroo River overflow. Artesian water was encountered at a depth of 53 metres. By 1910, there were 364 artesian bores in NSW. Bores were being constructed not only for the growing pastoral industry, but also for town water supplies and mining activities. Of the 1400 bores tapping the deeper aquifers of the GAB in NSW, around half have stopped flowing. About one-third of the mound springs have dried up.

The first bore drilled to tap the water of the GAB in South Australia was at Tarkannina in 1883. The bore was similarly drilled in the bottom of a well, which penetrated to a total depth of 373.4 metres. In Queensland, investigations headed by Dr. R.L. Jack (Government Geologist) and Mr. J.B. Henderson (Hydraulic Engineer) led to the first artesian water bore drilling at Blackall in 1885, using a Pennsylvanian Walking Beam Oil Rig. The first artesian flow to be obtained was on Thurrulgoonia Station near Cunnamulla and Barcaldine in 1887, using a Canadian Pole Tool Rig. In the Northern Territory, the Anacoora bore was sunk by the South Australian Government in 1898. The bore was an experiment to test the country for artesian water, with a view to providing a stock route to Queensland. The bore was drilled with a rig constructed on site with parts being carried in by camel, completed using casing delivered from England. Artesian water was struck at 346 metres. The extent of artesian conditions was reasonably defined by the end of the nineteenth century, and the early twentieth century saw the development and rapid expansion of the pastoral industry into more remote areas. Development of artesian bores slowed down due to WW1 around 1915 and it is sometime after this date that the total flow from GAB bores began to rapidly decrease, despite new bores being drilled. By 1952, around 2800 bores had been drilled, approximately 2300 in Queensland. There are currently 3300 artesian bores within the GAB.

The exploitation of GAB water for agricultural purposes was first used in central western Queensland in 1887 (Godwin and O'Oste-Brown 2012: 56). In Queensland, the first artesian bores were sunk at Thurulgoonia in 1886, followed by huge successes at Barcaldine, Blackall, and Charleville. The success of the Blackall bore led to a period of 'artesian mania', with pastoralists everywhere across west Queensland investigating how to sink bores on their properties; and by the end of 1899, a total of 524 bores had been sunk, of which 505 had been successful. (Blake and Cook 2006: 16). Artesian water was extensively tapped into to water stock routes across inland Australia, in early mining development, railway development, and for general domestic uses. Soon after the discovery of artesian water, the question of how to best harness the water for irrigation purposes arose. Sir Thomas McIlwraith was an early advocate for using artesian water for irrigation purposes in Queensland (Blake and Cook 2006: 45) and Walter Gibbons Cox devoted a chapter ‘Irrigation from Artesian Bores’ in his treatise *Artesian Wells* as a means of water supply (1895). However, despite the early success of tapping into artesian water supplies, concerns were raised. Most notably, J.B. Henderson expressed concern that the flow was diminishing and suggested that controls on how the water should be used be put in place. In 1954, a report on artesian water supplies in Queensland concluded that artesian water was generally unsuitable for irrigation purposes (Blake and Cook 2006: 46).

The assumption that artesian water would drought-proof pastoralism in the region was very quickly shown to be false. While the first well was dug at the beginning of the great drought of the late 1880s, providing permanent drinking water did not overcome the effects of drought. Sheep could not eat water and they died by the millions. It was very much an illusion of riches. This lesson took some time for pastoralists to learn, their traditional response being to overstock when wool prices boomed and seasons were good. However as McKeon et al. (2004) and many others have noted, this translated to the long-term degradation of the very pastures they depended on and set the scene for the creation of the Western Lands Commission as the primary vehicle for government management of the region.

6.8 A Finer Scale: Toorale Station

Toorale station was established in 1857 and represents in material form many of the themes I have been discussing. The station is situated located on the Darling River (on its confluence with the Warrego) and at its height comprised 500,000 acres. Throughout its history Toorale has been far too big to operate as a family enterprise, having been established by groups of investors who traded the property until it was finally purchased by the Australian government in 2008. Toorale (and its owners) were always at the whim of the commodity markets and the fortunes of the property rose and fell with the wool price set in London, thousands of kilometres away.

Significantly, pastoral operations on Toorale changed in the interim, most recently with a large portion of its river frontage being set aside for growing and irrigating cotton. There was a long history of controlling and impounding water at Toorale, at the beginning to try to create more stable water supplies for stock; but at the end the farming model diversified into agriculture as well as pastoralism. All of the investment in technology that we see in other pastoral enterprises can be found on the site, with additional structures and works associated with using paddle streamers on the Darling to transport wool. Research will focus on linking the extensive archives of the various companies that owned the station over the course of its history with precise documentation of the material culture of pastoralism located on the site—ranging from buildings, to yards, gardens, and workshops.

The history of Toorale gains additional significance in two ways. First, in 2008 it was purchased by the Federal and New South Wales governments for $24 million Australian dollars. The purpose of the purchase was to ‘buy back’ the allocation of water drawn from the Darling to Toorale, effectively releasing hundreds of thousands of mega-litres from impoundment on the property back into the Darling. This action was a direct response to widespread fears for the continuation of environmental flows on the river, which were the result of increasing use of river water for agriculture rather than pastoralism. In this sense the end of pastoralism at Toorale (it is now a National Park) is a symbol of the profound changes that have taken place in the Western Division of New South Wales. It has also provided an opportunity for local indigenous groups to reassert their connection to the place and to tell their stories to the many visitors to the park. The second point of significance extends from the first. Toorale fosters a contemplation of the lives of those who lived and worked there, both black and white. Toorale was a place of loneliness and hardship, where life was fundamentally different to that in the city and where dreams of home could sometimes obscure clear vision. How else would one of the early workers at the station, T.A. Matthews originally from the verdant valleys of County Louth, give this name to the nearest town—which he founded! Why else as a strong Republican would he name the local pub the Dan O'Connell, after the great Irish patriot.

6.9 Concluding Remarks

In this short essay I have sketched the some of the dimensions of long-term multidisciplinary research into the historical archaeology of extensive pastoralism in the arid zone of Australia. Core elements of the research design include a multi-scalar approach that reveals significant data at the level of the individual pastoral enterprise, the region, the nation of Australia, and more general the global trade in wool. This multi-scalar approach allows us to knit together data from a wide variety of sources—climate, the impact of hard-hoofed animals on the rangelands of Australia, the impact of technologies related to the provision of water and the large-scale management of sheep and the wool they produce (including transportation technologies such as river boats and railways), the impact of the introduction of feral animals from Europe, and the influx of significant populations of migrants from as far afield as Afghanistan and Ireland.

While it is self-evident that the introduction of extensive pastoralism to the Western Division of New South Wales from the mid-nineteenth century had serious and long-lasting impacts on the fragile ecology of the region, it is even more obvious that that same process completely recast the lives of its indigenous inhabitants. The fates of these original inhabitants (whose descendants have maintained their culture and ties to their ancestral lands) mattered little to most pastoralists, who dispossessed them to acquire and use vast tracts of land to amass significant wealth.

But these truly fundamental transformations do not completely encompass the impact of the process of settlement in this remote and fragile landscape. It was well understood in the nineteenth century (as can be seen through the poetry of such as Henry Lawson (1896) and Banjo Patterson, and the journalism of C.E.W. Bean and others, see e.g., Grattan 2004) that the people of the Western Division had acquired an aura of toughness, commitment, and single-mindedness that was popularly thought to define the Australian character. Certainly Bean, whose 1910 ode to the wool industry of the Darling River might be regarded as a foundational text in this regard, went on to make it abundantly clear in his official history of Australia in the First World War that the fighting spirit of the Australian soldier was born in the adversity of the Outback (Bean 1940).

On the other hand, many pastoralists developed a lasting antiquarian interest in indigenous material culture, assiduously collecting objects to be displayed in their houses, but also gifted to major metropolitan museums (and through them being circulated to museums as far afield as the United States and Russia). Quite a lot has been written about such collecting and its motivation (see, e.g., Griffiths 1994)—it can, indeed, be seen as a continuing act of dispossession, erasing the past as well as the present and the future of indigenous societies in the region. Nonetheless the passage of time has made several facts very clear—no such permanent erasure has taken place and the survival of indigenous communities has fundamentally altered the calculus of identity here.

Of course, this is just one of the lessons of history—power relations between community members, both black and white, change. But there are other profound lessons that are yet to be learned. The most obvious of these is the difficult business of learning to live with the environmental constraints of the region and to adopt sustainable land use strategies. There is a difference between living in and living with Australia. Historical archaeology has much to contribute to this process.

References

Allison, P. M. (2003). The Old Kinchega Homestead. Doing Household Archaeology in Outback NSW, Australia. *International Journal of Historical Archaeology, 7*, 161–194.

Appadurai, A. (1996). *Modernity at large: Cultural dimensions of globalization*. Minneapolis: University of Minnesota Press.

Bairstow, D. (2003). *A million pounds, a million acres: The pioneer settlement of the Australian agricultural company*. Cremorne: The author.

Barnard, A. (Ed.). (1962). *The simple fleece: Studies in the Australian Wool Industry*. Carlton: Melbourne University Press.

Barnes, M., & Wise, G. (2003). *100 years: Celebrating 100 years of natural resource progress in the western division of New South Wales: Learning from the past and planning for the future*. Dubbo: Department of Sustainable Natural Resources.

Bates, B., & Martin, S. (2012). *Following Granny Moysey: Kurnu-Paakantyi stories from the Darling, Warego and Paroo*. Canberra: AIATSIS.

Bean, C. E. W. (1910). *On the wool track*. Sydney: Angus and Robertson.

Bean, C. E. W. (1940). *The story of ANZAC*. Sydney: Angus and Robertson.

Berger, P. L., & Huntingdon, S. P. (2002). *Many globalizations: Cultural diversity in the contemporary world*. Oxford: Oxford University Press.

Birmingham, J., & Jeans, D. (1983). The Swiss Family Robinson and the archaeology of colonisation. *Australian Journal of Historical Archaeology, 1*, 3–14.

Blainey, G. (1966). *The tyranny of distance. How distance shaped Australia's history*. Melbourne: Sun Books.

Blake, T., & Cook, M. (2006). *Great Artesian Basin: An historical overview*. Brisbane: Department of Natural Resources and Mines.

Bonyhady, T. (2000). *The colonial earth*. Carlton: Miegunyah Press.

Butlin, N. G. (1962a). The growth of rural capital 1860–1890. In A. Barnard (Ed.), *The simple fleece* (pp. 322–339). Carlton: Melbourne University Press.

Butlin, N. G. (1962b). Pastoral finance and capital requirements. 1860–1890. In A. Barnard (Ed.), *The simple fleece* (pp. 383–407). Carlton: Melbourne University Press.

Butlin, N. G. (1994). *Forming a colonial economy, Australia 1810–1850*. Melbourne: Cambridge University Press.

Butzer, K., & Helgren, D. (2005). Livestock, land cover and environmental history: The tablelands of New South Wales, Australia, 1820–1920. *Annals of the Association of American Geographers, 95*, 80–111.

Coman, B. (1999). *Tooth and nail: The story of the rabbit in Australia*. Melbourne: Text.

Condon, D. (2002). *Out of the west: Historical perspectives on the western division of New South Wales*. Yowie Bay: Rangeland Management Action Plan.

Contreras, D. (Ed.). (2017). *The archaeology of human environment interaction*. London: Routledge.

Crosby, A. W. (2004). *Ecological imperialism: The biological expansion of Europe 900–1900* (2nd ed.). Cambridge: Cambridge University Press.

Croucher, S., & Weiss, L. (Eds.). (2011). *The archaeology of capitalism in colonial contexts*. New York: Springer.

Cumins, R. (1989). Scouring the clip. Boom and burn on woolscour lane. *Australian Historical Archaeology, 7*, 23–28.

Davidson, B. R. (1994). The development of the pastoral industry in Australia during the 19th century. In C. Chang & H. A. Koster (Eds.), *Pastoralists at the periphery. Herders in a capitalist world* (pp. 79–102). Tucson: University of Arizona Press.

Elliot, J. H. (2006). *Empires of the Atlantic World: Britain and Spain in America 1492–1830*. New Haven: Yale University Press.

Frost, L. (2014). Urbanisation. In S.Ville and G. Withers (eds.) (2015). The Cambridge Economic History of Australia. Melbourne: Cambridge University Press.

Gill, N. (2005). Life and death in the Australian 'heartlands': Pastoralism, ecology and rethinking the outback. *Journal of Rural Studies, 21*, 39–53.

Glick Schiller, N., Basch, L., & Blanc-Szanton, C. (Eds.). (1992). *Towards a transnational perspective on migration: Race, class, ethnicity, and nationalism considered*. New York: New York Academy of Sciences.

Godwin, L., & L'Oste-Brown, S. (2012). 'Water water everywhere': Attempts at drought-proofing properties using surface water indrastructure in central West Queensland in the early 1880s. *Australian Archaeology, 74*, 55–70.

Gorman, E. (2012). *Flood Country: An environmental history of the Murray-Darling Basin*. Canberra: CSIRO.

Grattan, M. (2004). *Back on the wool track*. Milsons Point: Vantage.

Griffiths, T. (1994). *Hunters and collectors*. Melbourne: Cambridge University Press.

Griffiths, T., & Robin, L. (Eds.). (1997). *Ecology and empire: Environmental histories of settler societies*. Melbourne: Melbourne University Press.

Hall, M. (2000). *Archaeology and the modern world: Colonial transcripts from South Africa and the Chesapeake*. New York: Routledge.

Hancock, W. K. (1972). *Discovering Monaro: A study of man's impact on his environment*. Cambridge: Cambridge University Press.

Harrison, R. (2004). *Shared landscapes: Archaeologies of attachment and the pastoral industry in New South Wales*. Sydney: UNSW Press.

Hume, L. J. (1962). Wool in the Australian economy 1946-1958. In A. Barnard (Ed.), *The simple fleece* (pp. 615–627). Carlton: Melbourne University Press.

Jack, R. I. (2008). Heritage in a historic landscape, the case of Toorale Station. *History, 98*, 2–3.

Jupp, J. (2007). *From White Australia to Woomera: the story of Australian immigration* (2nd ed.). New York: Cambridge University Press.

Lawson, H. (1896). *In the days when the world was wide and other verses*. Sydney: Angus and Robertson.

Leone, M., & Potter, P., Jr. (Eds.). (1999). *Historical archaeologies of capitalism*. New York: Plenum.

Letnic, M. (2007). The impacts of pastoralism on the fauna of arid Australia. In C. R. Dickman, D. Lunney, & S. Burgin (Eds.), *Animals of arid Australia: Out on their own* (pp. 65–76). Mosman: Royal Zoological Society of New South Wales.

Linge, G. J. R. (1979). *Industrial awakening: A geography of Australian manufacturing 1788–1890*. Canberra: ANU Press.

McKeon, G., Hall, W., Henry, B., Stone, G., & Watson, I. (Eds.). (2004). *Pasture degradation and recovery in Australia's rangelands. Learning from history*. Indooroopilly: Natural Resource Sciences, Queensland Government.

Merritt, J. (1998). Wool. In G. Davison, J. Hirst, & S. Macintyre (Eds.), *The Oxford companion to Australian history* (pp. 690–691). Melbourne: Oxford University Press.

Mitchell, B. (1998). Pastoral history. In G. Davison, J. Hirst, & S. Macintyre (Eds.), *The Oxford companion to Australian history* (pp. 499–501). Melbourne: Oxford University Press.

Mullins, P. (2008). 'The strange and unusual': Material and social dimensions of Chinese identity. *Historical Archaeology, 42*(3), 152–157.

Murray, T. (1992). The discourse of Australian prehistoric archaeology. In B. Attwood (Ed.), *Power knowledge, and Aborigines* (pp. 1–19. A special issue of the Journal of Australian Studies). Melbourne: La Trobe University Press.

Murray, T. (1996). Towards a post-Mabo archaeology of Australia. In B. Attwood (Ed.), *In the age of Mabo* (pp. 73–87). Sydney: Allen and Unwin.

Murray, T. (2000). Digging with documents. Understanding intention and outcome in Northwest Tasmania 1825–1835. In A. Anderson & T. Murray (Eds.), *Australian Archaeologist. Collected papers in honour of Jim Allen* (pp. 145–160). Canberra: Coombs Academic Publishing.

Murray, T. (2004). The archaeology of contact in settler societies: An introduction. In T. Murray (ed.), *The archaeology of contact in settler societies* (pp. 1–18). Cambridge: Cambridge University Press.

Murray, T., & Crook, P. (2005). Exploring the archaeology of the modern city: Melbourne, Sydney and London in the 19th century. *International Journal of Historical Archaeology, 9*(2), 89–109.

Murray, T., Crook, P., & Ellmoos, L. (2003). Understanding the archaeology of the modern city. In T. Murray (Ed.), *Exploring the history and archaeology of the modern city* (pp. 113–136). Sydney: Historic Houses Trust of NSW.

Orser, C., Jr. (2010). Twenty-first-century historical archaeology. *Journal of Archaeological Research, 18*, 111–150.

Orser, C., Jr. (1996). *A historical archaeology of the modern world*. New York: Plenum.

Parker, B. J., & Rodseth, L. (2006). *Untaming the frontier in anthropology, archaeology and history*. Tucson: University of Arizona Press.

Parthasarathi, P., & Riello, G. (2014). The Indian Ocean in the long eighteenth century. *Eighteenth Century Studies, 48*(1), 1–19.

Paterson, A. G. (2005). Early pastoral landscapes and culture contact in Central Australia. *Historical Archaeology, 39*(3), 28–48.

Paterson, A. G. (2010). The archaeology of historical indigenous Australia. In J. Lydon & U. Rizvi (Eds.), *The handbook of postcolonialism and archaeology* (pp. 165–184). Walnut Creek: Left Coast Press.

Pearson, M. J. (1982). The excavation of the Mount Wood Woolscour, Tiboobura, New South Wales. *Australian Journal of Historical Archaeology, 2*, 38–50.

Pearson, M., & Lennon, J. (2010). *Pastoral Australia. Fortunes, failures and hard yakka. A historical overview 1788–1967*. Canberra: CSIRO Publishing.

Riello, G. (2013). *Cotton. The fabric that made the modern world*. Cambridge: Cambridge University Press.

Robin, L. (2007). *How a continent created a nation*. Sydney: UNSW Press.

Robin, L. (2009). Fleecing the nation. *Journal of Australian Studies, 23*, 150–158.

Robin, L., Dickman, C. R., & Martin, M. (2010). *Desert channels: The impulse to conserve*. Canberra: CSIRO.

Saunier, P.-Y. (2013). *Transnational history*. New York: Palgrave.

Silliman, S. (2005). Culture contact or colonialism? Changes in the archaeology of native North America. *American Antiquity, 70*(1), 55–74.

Stanniforth, M., & Nash, M. (Eds.). (2006). *Maritime archaeology: Australian approaches*. New York: Springer.

Ville, S. (2000). *The rural entrepreneurs: A history of the stock and station agent industry in Australia and New Zealand*. Melbourne: Cambridge University Press.

Ville, S., & Withers, G. (Eds.). (2015). *The Cambridge economic history of Australia*. Melbourne: Cambridge University Press.

Walker, M., & Forrest, P. (1995). Pastoral technology and the National Estate. Australia ICOMOS.

Williams, B., & Voss, B. (2008). The archaeology of Chinese immigrant and Chinese American Communities. *Historical Archaeology, 42*(3), 1–4.

Chapter 7
The Fishermen's Disappearance: An Archaeology of Cruel Modernity in São Paulo City

Rafael de Abreu e Souza

Abstract The transformation of São Paulo city's environment in the mid-twentieth century meant the absolute victory of the highway model. As a result, the land of periodic floods became known as the land of flooded streets. Today, as São Paulo faces an almost paradoxical shortage of water, an archaeology of the construction of the modern city shows how the urban world was designed to cleanse it off even the slightest trace of "nature." The entire drainage system of the upper Tietê basin underwent a process of total subjection to human control. In this process, a final blow was also inflicted upon a practice, and the specific social group who once carried it out: fishermen. This text seeks to highlight aspects of the disappearance of a little-known activity among the current inhabitants, but one which once had an undeniable weight in the history of the city's uplands: fishing. This article will deploy discrete material and historical sources about fishing in the city of São Paulo in the nineteenth and twentieth centuries. It aims to bring attention to the environmental impact of the urban material changes caused by a cruel modernity that caused the fishermen's disappearance.

Most Brazilians grow up hearing about their country's abundant natural resources. The constructed image of a country with water everywhere has established a certain feeling of abundance and a sense of infinite natural resources. The southeastern middle classes' delusions were shattered between 2014 and 2015, when water scarcity began to affect richest parts of the city of São Paulo, although it had previously been recurrent in poorer neighborhoods.

Brazil hosts the greatest water reserve in the world, making up 12% of the world's total amount (Bicudo, Tundisi and Scheuenstuhl 2010). Amazonian stereotypes rooted in foreign gazes on the country have only further disguised from common sense the fact that all this water is very unevenly distributed across the country's many ecosystems, and that it is embedded in the sociopolitical complexities of the Brazilian territory. It seems paradoxical that those inhabiting the world's greatest freshwater reserve should suffer water shortages. Few are aware of the *draught*

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industry in the country's northeast region, a long-standing political strategy by which politicians regularly profit from the semi-arid environment's dry season and the ensuing famines (Martinelli 2006).

The city of São Paulo, whose 14 million inhabitants make up one of the greatest urban conglomerates in the world, recently suffered one of the greatest hydric crises in the history of the upper Tietê River basin. The colonial city, founded amid great rivers and plains and once known for its floods, was also well known for its street floods in the nineteenth and twentieth centuries, and arrived at the twenty-first century in a government–declared state of crisis, announced on August 15, 2015. Drastic measures were imposed upon the city center: bars were made to ban flushing water after 5pm so a last-call final flush of all toilets took place at night before closing time. TV programs were filled with families being interviewed about water rationing and how they had been left without any water for drinking or bathing.

Researchers (Marengo and Alves 2016, Rodrigues and Villela 2016) from a wide range of disciplines have examined the so-called São Paulo water crisis, but attempts and social pressure to solve it only escalated when this socio-environmental problem began to affect more economically affluent groups. São Paulo is a living example of how, while globalization and modernity benefits had previously been restricted to some groups, truly universal and democratized access has only revealed the evils and negative impacts of these phenomena (Giddens 1991).

The city of São Paulo's history is one of a gradual and symbolic separation of inhabitants from water sources and of an abrupt physical severance from rivers. The process became even sharper in the late nineteenth and early twentieth centuries. At that time, a significant population increase had brought people and water closer together, because rivers provided an alternative source of income and resources. The encounter coincided with works of urban development that have shaped the city's features to this very day (Jorge 2006). It was the elitist policies of river-bed modification that expelled the populations living by the rivers, breaking affective links, eliminating possibilities of use, and preventing the construction of spatially grounded identities (Diniz 2013). Contemporary inhabitants of São Paulo are quite aware of how difficult it is to physically access rivers, isolated as they have become in the middle of avenues with no sidewalks and expressways without any strips, walled-in with channels made by abrupt protecting fences. Today, many rivers run through subterranean galleries sealed under thick layers of asphalt and concrete.

Archaeologists excavating the city of São Paulo are constantly finding vestiges directly or indirectly related to fishing practices, as well as traces of the occasional consumption of fish, and the remains of waterproofing and contention structures built into the city's complex stratigraphy (Oliveira 2005; Abreu e Souza 2013). Food remains, fishnet weights, and layer upon layer of waterproofing materials are all common archaeological findings, although they are rarely interpreted in relation to the city's history. The topic goes largely ignored in what appears to be the counterpart of urban ideologies and the processes of exclusion and marginalization of such social groups such as fishermen who, in turn, produced few or no written records of their own.

With some effort, more and more researchers (Jorge 2006; Gouveia 2016) are beginning to gather data about the city's relationship with water, and the existence or nonexistence of groups whose identities have been constructed around it. These were once violently marginalized and deprived of their basic material conditions of existence and prevented from social reproduction by the urban reforms of hygienists, and a cruel modernity which caused their physical and social disappearance. Brazilian archaeology has paid little attention to water and fishermen in any other respect than the exploration of pre-colonial archaeological contexts.

Archaeology has tended to consider rivers and water in different ways, generally as means of communication and determinants of human occupation. A handful of archaeologists have tried to go beyond such paradigms, understanding water and rivers as more than the mere natural scenery of human practices (Edeworth 2011; Normark 2014). Within Brazilian archaeology, studies of the fluvial world are tilted toward the coast, where most archaeological work seems to have been concentrated (except for research in the Amazon basin [Heckenberger and Neves 2009] and in the Pantanal basin [Eremites de Oliveira 1996]).

Water and rivers tend to disappear from the archaeologist's gaze when they become too polluted or hidden within the landscape, or wherever hydric dynamics have been too altered, as in São Paulo. In that respect, urban archaeology merely reinforces the same modern ideology that once gave rise to the city's present profile, and originally ignored channeled rivers, contributing to their oblivion from historic and social memory. Along the way, the various groups that once depended on the river and used to be identified with it suffered the same fate. After all, most archaeologists have been born and raised in cities, and tend to reinforce the modern discourses they perpetuate (Lucas 2004).

The aim of this text is to explore known materiality from a creative archaeological point of view: What are the sparse material references to fishing? Why are some streets of São Paulo named after ports? It is nearly impossible to find fishermen in São Paulo today, which raises the question of how the city of São Paulo has materialized in a way that has effectively erased certain groups through the appropriation, exploitation, and even exclusion of their material possibilities of existence, without remorse and ironically justified by the claim of improving urban habitability (Sampaio and Pereira 2003). Through the vestiges of fishing, of fishermen, and of fish, I immerse myself in the urbanization process of a *cruel modernity* (Franco 2013), whose material marks attest to a *genealogy of the destruction* (González-Ruibal and Hernando 2010) of fishermen. I seek to travel through *heterochronies* (Gonzalez-Ruibal 2008) and *allochronisms* (Fabian 1983) in an environment whose *roughness* (Santos 2012) indicates not just the existence of several different times and people, but also different relationships with the environment that give rise to different material phenomena. I highlight that the proximity between archaeologists and subject allows the development of socially critical and creative archaeologies dialogical to a Brazilian and Latin American context.

7.1 Cruel Modernity

In 1885, the newspaper *Correio Paulistano* reported on groups of fishermen casting their nets over the river Tietê, hunting and spending time (*Correio Paulistano* [1885a], 11 September, p. 3). In July 1899, the river attorney handed over to the supervising inspector 20 fishing baskets (*covos de malha*) confiscated on the river

Pinheiros, belonging to infringers of the explicit municipal ban on such techniques (*Correio Paulistano* [1889], 21 July, p. 3). A few years earlier, the river attorney himself had used dynamite to fish in the Tietê, as was also ironically commented in the newspaper (*Correio Paulistano* [1885b] 22 September, p. 2). In 1906, river attorney José Joaquim Freitas arrested and fined fishermen Francisco Itiz, Luigi Borelli, and João Vittor for using cast nets (*tarrafa*) to fish during the spawning season (*Correio Paulistano* [1906], 20 December, p. 4). In 2011, archaeologists excavating in a sector of the Pinheiros neighborhood located eighteenth-to-nineteenth-century fishing net ceramic weights of local/regional production and in 2010, unearthed a buried dumping site from an orphanage for girls full of fish bones of their day by day diet (Zanettini Archaeology 2009, 2011). In 2012 a broad-snouted caiman was found in the Tietê. What do these episodes of everyday life in the city indicate? That fishing was, to say the least, a familiar feature of various everyday aspects of life on the Paulista plateau. The question thus remains: why then is there no more fishing? Who used to fish? Where have the fishermen gone? If they are no longer here, what happened to them? Did they disappear?

Analyses of nineteenth-century iconography have shown how panoramic depictions of São Paulo used to feature rivers and wetlands in the forefront, clearly linking them to the practices of fishing and hunting, country activities, and fairs (Oliveira 1999). Floodplains and rivers were places of rural permanence, and, as such, were seen by the urban elites as the opposite of modern (Koguruma 1999). Different discourses about modernity shared "wills of truth" and their power of coercion over other discourses generated systems of exclusion (Foucault 1971). Sharp blows were inflicted upon rivers and floodplains, upon fishermen, and upon anything seen as rural, a discourse exemplified by the 1916 avenue plan of mayor Washington Luiz, which called for "total sanitation," combining urban development and hygienist theses (Oliveira 1999; Pinto 2002, Okano 2007).

The then colonial town of São Paulo de Piratininga was being built from several different centers (Zanettini 2005). As it developed and these grew into each other, the resulting constellation acquired an increasingly urban character, eventually originating one of the greatest conurbations in the world. The city spread over a rich hydrographic network, on the basin of the rivers Tietê, Pinheiros, and Tamanduateí and their innumerous tributaries, forming lakes and wetlands. To Ab'Saber (2003) the main geographical originality of the urban site of São Paulo lies in its implantation over a small mosaic of islands, river terraces and floodplains.

Until the mid-twentieth century, urbanization had taken place mainly on the hills, and only began to expand onto plains and terraces later (Gouveia 2016). That ecosystem had played a fundamental role in the inhabitants' diet and identity, as well as in the occupations and formation of different social groups. Ultimately, it provided the material support for a city which would eventually destroy it. With such an enormous hydrographic network, it would be naïve to assume that there was no fishing in the city, just because rivers are no longer visible. Despite being minor figures in written sources, fishermen were an important, even integral, part of the city. Rendering them archaeologically visible requires several intersecting gazes.

Unfortunately, diachrony has not exactly been the forte of narratives about water and the São Paulo hydric crisis, with studies displaying little chronological depth, despite the efforts of some environment historians (Jorge 2006). Little attention has been paid to the genealogy of the city's present landscape. Attention tends to focus on water consumption as a "supplying crisis" (Rodrigues and Villela 2016), rather than on the consequences of its uncontrolled use or the way in which this has affected different social groups, a topic of an undeniable material dimension.

Gazing at the ceramic fishing-net weights or the old river ports as reflected by cartography means gazing at modernity in São Paulo and the full spectrum of its nefarious character. It means coming to grips with the materiality of a genealogy of destruction brought on by modernity itself (González-Ruibal and Hernando 2010) and its wicked potential to erase an entire social segment and its landscape.

It is no coincidence that the rivers of São Paulo are described as hidden and invisible. Materially erased, beneath the surface, rivers remain invisible to the eyes of urban passersby and drivers. They are often seen as causing a bad smell when they emerge in open canals or simply ignored or considered as unwanted presences. The urban rivers of São Paulo exemplify historic relationships between society and river courses which are intimately linked to such socio-spatial processes as urbanization and the social problems of modernity (Silva 2014).

The material disappearance of rivers and fishermen and archaeological encounters with the materiality that refers to them directly or indirectly attests to a cruel side of modernity. In this article, I take up the ideas of anthropologist Jean Franco (2013), to whom Latin American modernity has been, above all, cruel: the discourse of opposition between civilization and barbarism was implanted in South America to disguise violent practices. The State has represented fishing, indigenous, and guerrilla populations as enemies of modernity and encouraged perception of them as threats to civilization, making them the natural targets of violence. One of the strategies used by the State and its dominant sectors has been to cause the physical and social disappearance of those who did not conform. Direct disappearance took place during the military dictatorship, when blanket repression was used, while, in the case of fishermen, they have been undergone indirect disappearance. Having been caused to disappear for the benefit of modernity, they have ironically become the present-absent (Buchli and Lucas 2001) evidence of the State's cruel acts.

The materiality of cruelty can be quite evident or it can be subtler, as it is in São Paulo, where it creeps through basements and hides in the bushes or behind well-known facades, materializing into absences or into the sudden flashes of something which once was. To highlight the cruelty of modernity, I navigate its roughness waters, searching for heterochronies against the shallow depths imposed by modernity (Harrison 2011). I turn to geographer Milton Santos (2012), who understands roughness as "what is left of the past as a shape, as constructed space, as landscape, what is left of the process of suppression, accumulation, superposition, by which things substitute and accumulate everywhere", to social anthropologist Johannes Fabian (1983) for who allochronism is the placement of a social group in a different temporal plan by hegemonic discourse and to archaeologist Alfredo Gonzalez-Ruibal (2008) to who archaeology should goes against homogenized time of modernity in the search of multiple contemporaneous times.

Can archaeology contribute to this discussion by producing socially relevant knowledge about the hydric crisis, and go beyond merely illustrating the research of historians and sociologists? Yes: we can address the issue from the point of view of materiality, because changes connected to the São Paulo water crisis are especially material—the modern city being one of the greatest material expressions of humanity (Santos 2004). We can address the question in greater chronological depth by verticalizing time (Dillehay 1996), and by highlighting the several temporalities involved. Looking at the water crisis from the standpoint of the archaeology of the contemporary past in São Paulo allows us to apply an archaeological viewpoint from the geopolitical south which is closer and less generalizing (Gonzalez-Ruibal 2012) and to focus on socio-environmental problems and the disasters caused by modernity (Gonzalez-Ruibal 2014).

The materiality that allows us to understand the disappearance of fishermen is invisible yet not small; some of its elements are so massive in scale that they fool us on first sight: the great channeling works, the highway model materialized into asphalt and concrete streets and avenues, and the waterproofing structures which once helped to erect the modern city as an icon of absolute control over nature. In what follows I shall expand on the following three points: (a) the fishermen and the pressures exerted by capitalist modernity on fishing, which turned it into an unsustainable activity; (b) the channeling of rivers and opening of avenues, which reconfigured the hydrographic network of São Paulo; (c) the waterproofing of urban soil that prevented physical access to water. All three of these cruel practices, which caused fishermen to disappear, provide useful insights into the hydric problems of contemporary São Paulo.

7.2 The End of the Fishermen

The fishermen's disappearance was caused by the destruction of natural resources, but it would be naïve to state that they did not participate in this destruction themselves. The modern threat to their way of life left them no alternative but to overexploit the rivers. In a cruel and perverse turn, modernity placed them under the capitalist pressure of having to cater to a population in the process of exponential growth and hygienic urbanization; thus, fishermen were driven to self-destruction through the adoption of increasingly devastating fish-obtaining technologies. This is not the first archaeological glimpse into capitalist modernity's ability to make the existence of fishermen unsustainable, as the case of Antarctic seal hunters illustrates (Zarankin and Senatore 2007).

The former presence and process of disappearance of fishermen in São Paulo can be traced through different sources: excavating the city, rare vestiges can be found that refer to them: fishing-net weights appear (Zanettini Archaeology 2009), made of ceramics or lead, as well as some faunal vestiges in little-analyzed urban rubbish bins (Zanettini Archaeology 2011). Extensive fishing-net weight production by large-scale pottery-manufacturing sites indicates the role of fishing on the plateau.

Newspapers also referred to fishermen both as disrupting figures within the image of a modern city because of their "primitive" and allochronic fishing techniques and sometimes as unionized workers as fishing became recognized as an important profession necessary to meeting the city's demands. Fishing, the fishermen, and their cities, rivers, and lakes all represented other temporalities, heterochronies opposed to the homogeneous time which super-modernity attempted to impose (Gonzalez-Ruibal 2008).

Due to a population boom between the 19th and the 20th century, fish consumption increased. An emerging context of commercialization began to require greater controls from the State over fishing activities and over other fish-obtaining technologies. Harpoons and angling were gradually replaced by the use various types of increasingly wider and more complex nets. Especially in the early twentieth century, the nationalization of fishing activities progressed and brought about the earliest forms of fishing-activity industrialization in the city (Ramalho 2014). In the 1890s the Santista Fishing Company established its headquarters in São Paulo to better exploit the fishing industry, its products' manufacturing, and trade. The company built its main office at the center of the city and began to take orders for any amount of fish, oysters, and prawns (*O Mercantil* [1891], 13 January, p. 3).

Traditional techniques gained a new dimension and were redefined to obtain more and more fish to satisfy increased demand. The intensification of indigenous techniques, such as the *pari*—employing nets and the *timbó* and the use of ichthyotoxicity to paralyze fish—elicited increasing criticism from more and more quarters and accusations of killing more fish than it was possible to collect and eat. Also, both *pari* and fishermen were increasingly forced to share their space with the members of the elite yachting clubs, competing over territories where the latter group saw coexistence as out of the question. Bottom trawling and trawling nets were also the object of scalding disapproval but were nonetheless increasingly used. Because of these issues, the knowledge of fishermen and their very place in the modern city were harshly criticized. In a final effort to obtain enough fish to meet increased demand, many fishermen turned to dynamite, a modern military technology which, in the inter-world wars years had become widespread. Its impact on the already polluted rivers was enormous, and the over-exploitation of fishing in the city ended with the fishermen destroying their own means of existence.

And yet there is no denying that fishing was a major factor in the survival of an important sector of the population of São Paulo (Oliveira 2007). With its enormous hydrographic network, the upper Tietê basin has lengthy rivers, which were once navigable and associated with an entire range of draining systems. Certainly, European settlement on the Paulista plateau and the foundation of the Piratininga village had been major turning points in the several interactions between practices and the ways of life of the populations here settled. The material culture of fishing technology, often the object of pre-colonial archaeology on the coast in the context of fisher-gatherers activities (such as on shell mounds), suggests that, despite the few vestiges related to ancient indigenous occupation in the region, these were also probably very frequent where the city stands today.

Fish consumption, based on fishing in the rivers around São Paulo, had been an important feature of city life for a long time (Bruno 1953). The presence of rivers, indispensable for the human occupation of the uplands, has been highlighted by historians working on human occupation systems. Settlement and supply depended on the possibilities afforded by fishing and the availability of drinkable water for subsistence, as well as transportation through river and streams which also helped commercialize production (Blaj 2002). In addition, river plains provided the materials for the potteries which produced enough pots and ceramic pans for the entire region (and beyond) and contributed to the everyday sustenance of a great part of the population (Zanettini and Whicher 2009).

Caio Prado Jr. (1953) has highlighted how the period between the November 15th, Direita, and Comércio Streets was the "natural center of the region's hydrographic system, that is, the point from which rivers irradiate in all directions, serving as the natural paths of communication, and of food provision (fishing)." Alfonso Taunay (2004) has, on various occasions, highlighted the importance of fishing dynamics in the history of the city of São Paulo. For him, the proliferation of fishing-tackle shops in the 1850s spoke volumes about the city's notorious specialization. The eighteenth century saw the first drafting of regulations on the sale of fish from the Tietê and its tributaries, in both fairs and streets.

Travelers' reports also make several remarks about fishing and fish consumption, highlighting that fish was cheaper than beef, and therefore more common in the Paulistano diet (Sant'Anna 2007). It is worth remembering that Princess Isabel (1957), on her visit to São Paulo in November of 1884, which was still during Imperial times, recorded her encounter with the skillful net-caster João Cachoeira and his helper Dionísio, on an excursion down the river Tietê she took to observe the casting of fishing nets and other fishing arts.

No doubt, João and Dionísio were once part of the many social groups that either made their living fishing or turned to fishing as a response to the harsh nineteenth-century urban poverty in the city. Between the late nineteenth century and the mid-twentieth century, fishing was also part of the everyday set of activities of many who depended on hunting, fishing, and gathering to survive, including *caboclos*, *mamelucos,*[1] immigrants, ex-slaves, and other characters (Jorge 2006). Fish consumption and the role of fishing were discussed as some of the reasons why workers suffered from poor nutrition. Some commentators encouraged the use of more traditional fishing techniques, such as fishing lines and hooks, which they saw as potential ways of ultimately improving workers' nutrition (*Correio Paulistano* [1909a], 25 January, p. 2).

But in fishing neighborhoods, where the fishing actually took place as a form of social and identity reproduction, the activity slowly turned into a profession, it growth spurred by a growing demand for fish in the city. The fishing trades created a market for fishing gear and created a constellation of associated arts. The following leaflet from *Il Pasquino* newspaper (1922) shows the Fratelli Del Guerra's fishing-gear shop long list of fishing artifacts (Fig. 7.1):

The increased number of competing fishing agglomerations in São Paulo indicates a growth in the demand for both fisherman and fish. Professional fishermen were soon settled in the neighborhoods of Santa Ifigênia, Brás, Freguesia de Ó, and Limão (Sant'Anna 2007). A small community of fishermen, including Italian

[1] *Caboclo* was used to refer to a person of indigenous or mixed ancestry, African or European, usually from rural areas. *Mameluco* was a word used to refer to a person of European and indigenous descent.

Fig. 7.1 Leaflet from *Il Pasquino* newspaper, 1922, selling different kinds of fishing nets. (National Library)

immigrants, settled in the Cambuci neighborhood, the fishermen's street on the Tamanduateí riverside, which was directly affected by the start of straightening works on the river in 1897, which distanced the community from the waterbed (D'Agostini 2013). Newspapers show recognizable fishermen and their everyday events: in 1899 the body of Italian fisherman Carlos Febre was found in a canoe on the river Tietê as reported in the *Correio Paulistano* ([1899a], 13 May, p. 1); in 1910 the same newspaper described an argument between a wagon driver and fisherman Francisco Miguel during a football match (*Correio Paulistano* [1910], 20 August, p. 3). Also, in 1928, another newspaper reported the running-over of a fisherman from the neighborhood of Limão (*Diário Nacional* [1928b], 31 August, p. 1).

The neighborhood of Pari, sitting on the wetland region of Tamanduateí, close to the point where it meets the Tietê, also attests to that process. The neighborhood kept its *tupi* toponymy, which relates to the indigenous river fishing technique *pari* (a type of fishing cage), due to the presence of its skillful inhabitants. In the mid-eighteenth century, the presence of professional fishermen was recorded in the area, which attracted fishmongers from other regions (*Correio Paulistano* [1942], 06 May, p. 2). Later, the São Vito fair on Santa Rosa Street, in Pari, would gain prominence. Saint Vito was the patron saint of migrant fishmongers from Bergamo, in northern Italy, from where many settlers in the neighborhood were—including those who organized the celebration—were from (Jorge 1942). The existence of so many different groups from so many different backgrounds was so intermeshed in the context of eighteenth-century São Paulo that it becomes almost impossible to establish whether any of them had originally been indigenous, African, or European. Such complexity indicates the extent to which the fisherman "is the result of a gradual making which simultaneously makes he who does it" (Duarte 1999).

Through the eighteenth and nineteenth centuries, fishing and capitalist logic blended together to make a trade which created a certain type of individual suited to that professional activity. This led, in the nineteenth and twentieth centuries, to an even greater exploitation of fishermen, who began to work exhausting working hours (Queiroz 2015). It was at this time that fishing was becoming nationalized, through a series of measures justified by economic factors and aimed at developing the country's fishing industry and reducing fish imports while satisfying the increasing demand of urban centers in Rio, São Paulo, Belo Horizonte, Recife, and Salvador (Ramalho 2014). The value of fish increased in the market, as few fishermen managed to produce enough fish for a growing market. The corresponding categories of fisherman, based on the main fishing technique applied—for example, cast fishnet-maker (*tarrafeiro*), fishhook-maker (*anzoleiro*), and so on—began to proliferate.

In the second half of the nineteenth century, the commodification of fish in the upper Tietê basin and on the São Paulo and Rio de Janeiro coasts as well as in the state's backlands increased the amount of fish sold in the streets, fairs, and the markets of São Paulo. The eighteenth century saw the earliest signs of regimentation of open-air fresh-fish selling on São Bento Street and in the Lapa and Carmo neighborhoods (Sant'Anna 2007). Some vendors also sold fish, as did the dried goods stores, which they brought from other regions to the growing city. In 1862, a vendor on Direita street and the store of Joaquim José de Macedo, on Comércio street, sold fish, prawns, mussels, and the latest novelty—canned fish—from Santos, Santa Catarina, and Rio de Janeiro (*Correio Paulistano* [1880], 12 March, p. 3). In 1880, fresh fish was brought in from Santos to be sold on Market Square, after 11:30 in the morning (*Correio Paulistano* [1880], 12 March, p. 3). Fish from the river Paraná was also frequently available in São Paulo (*Diário Nacional* [1931], 18 November, p. 2).

In the 1890s, the Santista fishing company established its headquarters in the capital to better exploit the fishing industry and improve its manufacturing and marketing (*O Mercantil* [1890], 23 August, p. 1). With its offices on Travessa da Sé, it began to take orders of "any amount of fish, oysters, prawns and has in its stores a great amount of tinned fish, prawn boxes, barrels thereof and small anchors" (*O Mercantil* [1891], 13 January, p. 3). Competing with fishermen and responding to the hygienic demands of new eating habits, new ways of preparing and storing food, and new behaviors, the company sought to monopolize a growing market.

Cruel modernity was already present here, putting pressure on fishermen to produce more fish and making them abandon traditional techniques and turn to industrial exploitation. Forced to produce more and more to exist, fishermen were hampered by the public powers' increasing restrictions on their techniques. Beginning in the late nineteenth century, city regulations and provincial laws imposed rules of conduct on the population to regulate their habits, practices, and behaviors. In July 1899, the river attorney apprehended in the Pinheiros river "a used canoe and 20 trawls painted with pitch" which infringed Article 158 of the city regulations (*Correio Paulistano* [1899b], 21 July, p. 3).

The river attorney—a position first created in the late nineteenth century, then renamed to river and riverside attorney in the twentieth—was put in charge of ensuring the "cleanliness and non-obstruction of rivers and their margins, piers, bridges, riversides, rafts and loading and unloading of materials" (*Correio Paulistano* [1909b], 27 October, p. 2), of following up the alterations of waterbeds, non-licensed littering, to oversee river transport services, and implement the decisions of municipal provisions and provincial laws linked to fishing activities (Jorge 2011). These tasks were so many and demand so big that in 1909 the position of river attorney assistant was created (*Correio Paulistano* [1909b], 27 October, p. 2).

Closely linked to behavioral concerns in a society under siege by modernization projects (Sevcenko 1992), the consumer demands of an increasingly capitalist system were felt by innumerable subjects living the city. Extensive fish consumption required that fisherman obtain fish on a large scale, and capitalist-intensified fishing activities caused the beginning of such activities' decline and the end of a practice which had once been thriving. Mobility and uncertainty are both associated with fishing resources, extraction, commercialization, and consumption, and they are among the central problems of the fishing trade (Sautchuk 2007). Municipal regulations expressed concerns about fishing overload and its impact on the life of rivers, the quality of water, and the lives of the inhabitants. Among the tactics adopted by fishermen, whose materiality otherwise tends to be quite ephemeral, *pari* and *fecho*—closure—were definitely the most censured. During the Municipal Chamber's Session of March 3, 1883, deputy speaker Moraes Barros made a long speech about the *pari*, "a net which is cast across both sides of the river, over a current; in such a way that any fish that happens to be pushed down by the river stream is caught in this net," (*Correio Paulistano* [1885c], 27 March, p.1) and the *fecho*, a trap where the fish can enter but not exit, which establish a monopoly against the freedom of fish, for the exclusive benefit of a private individual (*Correio Paulistano* [1885c], 27 March, p.1).

Article 85 of the provincial laws of 1865 forbade *paris* and *fechos* specifically, considering them a threat to public health (*Correio Paulistano* [1865], supplement to number 2767). In 1867, the fine was raised from $20000 to $30000 Réis, plus 8 days' imprisonment and the obligation to dismantle traps (*O Ypiranga* [1867]). In 1869 provincial laws established that *paris* and *fechos* would be allowed through annual licenses issued by the Chamber, at $10,000 a license; moreover, only the owners of river cliffs and riversides could use this technique, which obviously excluded non-proprietors (*Correio Paulistano* [1869], p. 2). The *pari* is accused of obstructing rivers and extracting a greater amount of fish than necessary, reducing the concentration of river fish and compromising their ability to reproduce themselves (*Correio Paulistano* [1874], p. 2; *Correio Paulistano* [1891], 11 January, p. 1).

But the prohibition went even further. Ultimately, it posed the question of ownership of the water resources: Was the exploitation of these a prerogative of the state or of fishermen? Should an activity that brought benefits to the city be left in the hands of monopolies such as fishing companies? On the other hand, the ban on *pari* affected a traditional technique which afforded its participants a measure of self-reliance, although it was practiced at a different scale from that required capitalist demands. In this respect the *pari* ban was a ban on certain practices and ways of life which were linked to certain sectors of the population.

Another widely used technique among the fishermen of the Paulista uplands was the use of poisonous substances, ichthyotoxic plants, which induced paralysis in the fish and made them easy to capture. The use of vegetable fishing poison is ethnographically recurrent throughout the American continent (Heizer 1986). Known in São Paulo as *timbó* most often, less frequently as *tingui*, the technique refers to the use of vines with poisonous sap (Saint-Hilaire 1967). The *tinguijamento*—rife use of these techniques—in rivers and lakes, especially in *piracema*, when large schools of fish agglomerate in rivers, has been banned by since the end of the eighteenth century (Sant'Anna 2007; Oliveira 1999).

The ban on *timbó* had very little to do with any environmental concerns. In the 1930s, urban fishing industries began to study *timbó* in an attempt to control plagues and developed "Rotenone," a new insecticide tested by agricultural industrialists. The product's civilized name masked its connection with the much-maligned *timbó*, a technique still denounced as revealing the local populations' proneness to "laziness" and alleged desire for fast cash. Thus, the use of the term "Rotenone," a scientific name for the same substance, was justified by the desire to distance the practice from *timbó* (*Correio Paulistano* [1936], 20 December, p. 8).

Fishermen struggling to make a living could turn to forces of modernity, which had one of the most violent techniques to offer: the use of dynamite. Particularly popular in the first few years of the twentieth century, dynamite could be bought or made by fishermen themselves. The use of this technique affected all water life within a 250-meter radius, bringing to the surface fish, crustaceans, and shellfish in even more excessive amounts than did *timbó*, but these products were rejected by traders due to the dilaceration caused by the use of dynamite (Rebouças 2013). The use of dynamite, one of the most violent technologies of modernity, began in the mid-nineteenth century, but was only used on a large scale in the First World War, when it transformed civilian population bombings into the norm. The substance could not only kill and mutilate people and animals within seconds, but it could also flatten entire landscapes (Cole 2009).

In 1904, the São Paulo city hall issued a ban on fishing with dynamite or any other explosive, drug, or substance, whether poisonous or anesthetic, which rendered a great amount of fish useless. The ban imposed a fine and 5 days' imprisonment as sanctions (*Correio Paulistano* [1904], 27 September, p. 2). A lack of controls over fishing was blamed for fishermen's disrupting water life's reproduction and spawning periods; destroying the river with poison and explosives, dynamite and *timbó;* and dilacerating and destroying thousands of fishes in a single blow (*Correio Paulistano* [1891], 11 January, p. 1).

Apart from its impact on water resources, fishing did not fit well into the new concept of the city. To those who embraced modernity, it made sense to control (and if necessary combat) available technologies, as well as those who used them, depended on them, and were culturally and socially recognized by them. Capitalist modernity extended its vampirical embrace to rivers and fishermen, turning the practice of fishing into an inconvenience for the city. But the fact that fishermen themselves had been forced by ever-increasing demand to bomb the very landscape that provided their means of subsistence was still not modernity's final blow causing their self-perpetrated disappearance. A further step was required: it became imperative to destroy the materiality of rivers themselves.

Thus, as the modern city grew, it left less and less space for the paradoxical presence of São Paulo's fishermen. But cruel modernity was capable of pushing paradox even further toward the absurd, by eliminating the very physical existence of rivers. And by that logic, discourse met its own obviousness, and the fishermen confronted their erasure. Modern technologies sought to control nature—channeling, directing, and burying the city's drainage, to the point that hidden rivers often disappeared (Jorge 2006). Even today no one knows exactly where they run. With them, the inhabitants who had long occupied the Paulista uplands also disappeared. For the fishermen, the city of industry, automobiles, and speed left no space for their fishing technologies.

7.3 Hygienic Urbanization and the Waterproofing of the Urban Soil

The questioning of the fishermen's presence in the city, over-fishing, and the impact of fishing techniques on the ecosystem went hand in hand with a massive material transformation of the city: channeling and the triumph of the model of the highway, a very fast process that occurred between the 1930s and the 1960s. The city of floods had its rivers and its floodplains systematically occupied. Flooded areas began to be seen as unhygienic, inhabited by the poorer sectors of the city's population, and as possessing an uncontrollable nature, which needed to be contained in order for the city to make progress. The curvy, meandering courses of the rivers gave way to straight and sharply angled canals. In some instances, even the direction of water flow was inverted, as was the case with the Pinheiros river, which, since the 1940s runs upward toward its own source, emptying its pollution into the Billings Dam, which supplies the city of São Paulo. Built by the U.S. engineer Asa Billings for the Light & Power Company, this work stands as a monument to modern arrogance regarding rivers, raising the question: Why would we want to invert a river's stream?

In other times, the city, having been established between great rivers and rich in water springs and brooks, saw a swiftly increased imbalance between hydric availability and the population's access to water (Sant'Anna 2007). In the 1930s, a new urban paradigm was defined, which reduced water flows to structural elements and transformed valleys into road systems which encountered problems with rainwater drainage and the disposition of drains (Bartalini 2014). Channeling inflicted a severe blow on fishermen and other inhabitants whose identities were constructed around water, such as washerwomen, and also on river transport, on river beaches, on sports and leisure, and on animals and floral species. The work caused fishing neighborhoods to be left physically distant from rivers and lakes, not by their own displacement, but through changes in the river's design. The river's margins were destroyed and access to its bed was made impossible. The dumping of both industrial and domestic waste in river waters, which flowed through an entire set of channels made with stoneware, cardboard with bitumens, and metals or concrete also became the norm (Abreu e Souza 2013); but this is seldom made a topic of reflection.

Republican São Paulo saw the establishment of a sanitary service which coincided with the creation of a real estate market associated with sanitation and hygiene, and which combatted physical elements while it attacked the practices associated with them (Santos 2011). The Republic saw urban speculation significantly commodify and encroach upon lands previously covered by water streams, opening vistas for a new market of private companies eager to divide up and trade in former floodplains. To them, rivers were obstacles to urban development for due engineering intervention (Diniz 2013).

The coffee-growing boom had begun to transfigure the city beginning in the late nineteenth century, initiating a process of urban transformation which continues to this day, still dominated by the elites' rejection of rivers and wetlands and by real estate pressure which made urban speculation the city's most profitable activity (Sevcenko 2004). A great number of São Paulo's humid areas have thus been drained and buried by floodplain occupations that have transformed the landscape, interrupted eco-systemic processes, and altered surface draining (Sturemer 2008).

As a modern technology, channeling became entangled with questions about urban mobility, to the benefit of the car industry, intensifying the need for streets and avenues for an increasingly mechanized and motorized city. Highways affected less abundant rivers particularly, as their waters were shunted into subterranean tubes to make space for streets and avenues (in the 1990s, archaeologists found the old Anhangabaú brook brick tube while excavating the center of the city [Juliani 1996]). The negative effects of this strategy were soon felt: within this new landscape, more and more water ran through rivers-turned-streets with great force and at high speed. Thus, it originated the great floods which, until fairly recently, have been typical of São Paulo. But both channelings and highways were part of an even greater plan: the waterproofing of urban soil.

In the early twentieth century, widespread beliefs about hygiene and dogmas about family health caused signs of cleanliness to acquire an unprecedented importance (Carvalho 2008). Glazed and waterproof surfaces allowed the presence of "dirt" to be recognized, where more porous and darker surfaces had hitherto made them unnoticeable. The importance of surface waterproofing as a vector of cleanliness grew exponentially in an atmosphere of aseptic concerns, and altered everything from everyday artefacts, such as ceramics and white crockery, to building walls and street surfaces.

It must be remembered that the late nineteenth century saw the emergence of innumerable hygienic discourses and practices. Diagnosis, prophylaxes, and treatments were sought for illnesses that were rife in the southeastern region's urban centers, which had already become embroiled in continuing political turmoil, migratory waves, and the effects of the coffee crisis (Benchimol 2003). Among these disturbances was the Vaccine Revolt of 1904, following the declaration of compulsory prevention of chicken-pox in the city of Rio de Janeiro; the "military" means of persuasion deployed by the hygienists; and the Spanish flu of 1918 (Bertucci-Martins 2003).

Hygienist ideology consisted of "a set of principles which, destined as they were to drive the country towards "the truth" and "civilization," meant the de-politicization of historic reality, the a priori legitimation of decisions about public policies to be implemented in the urban environment" (Chalhoub 2006). Hygienists were pioneering in their articulation of a discourse about the life conditions of urban centers and in proposing drastic interventions to restore the balance of the urban organism (Schwarz 1993). Streets and public spaces became the theater of operations in a fight against dirt.

Hygienist ideology was in its heyday at the same time as segregationist measures began to be implemented for the sanitation and embellishment of cities, promoting countless urban reforms—from building long avenues, to suppressing vegetation, to burying of lakeside territories draining the lakes, which were all suspected to be disseminators of air-transmitted illnesses (Jorge 2012). The epidemics of Spanish fever and chicken-pox only seemed to corroborate the theses put forth by the doctors of public hygiene that the cause of these illnesses lay in the "organic predisposition" of individuals or in the environment itself (Benchimol 2003).

Against this backdrop, new ideas were put forth about what was to be considered dirty. Social medicine made direct interventions into the public space and the population's behaviors and customs, creating norms about what was considered hygienic and good for both the city and its inhabitants (Sant'Anna 2007). Hygienists working in laboratories and examining invisible beings solidified a discourse which saw infectious foci everywhere. The use of glass, varnishes, asphalts, and waterproof materials, visible all over the materiality of urban life, suited the interests of hygienist policies when it came to changing those habits which were considered "damaging" for public and private environments.

Journalist Guilherme de Almeida (*Diário Nacional*, 21/07/1927) bore comical witness to this process by recording the "varnish paranoia" and the obsession with using anti-microbe materials against all those beings that could transmit infections and contagious illnesses. The varnish industry was soon booming: "walls were varnished, as were tables, ceilings, lamps, cups, and the waiters' faces" (Almeida 2004).

This process of waterproofing was the expression of a hygienist-inspired urbanization and restricted direct access to waters which were already quite polluted. Urban-soil waterproofing and river channeling were used to accelerate streams and disperse polluted waters (Jorge 2012). The housing sector's alarming growth favored the rapid advance of building projects in traditional fishing areas. The rivers' physical space was reduced through the de facto privatization of water bodies, the building of blocking structures, and the proliferation of relentless land occupation linked to speculation (Queiroz 2015). Floodplain waterproofing and its result—water running increasingly faster over waterproof surfaces—generated the enormous São Paulo floods, especially during the summer. The city of waters and fishermen became the city of natural urban disasters.

In the case of São Paulo, these urban natural disasters were the result of socially produced phenomena caused by the cumulative effects of materiality on landscapes (Briggs et al. 2006). Three different effects were at once the cause and consequence of methods employed to occupy urban space, of the strategies deployed for such an adaptation, and of the city's socio-spatial characteristics.

The second half of the twentieth century saw São Paulo become the object of a discourse about anthropic floods, which were presented in contrast to natural river floods. This discourse was connected to the role of successive plans developed to redefine the practice of living in the city (Santos 2011). The more the modern city advanced over its own older waters, the more the old floods reemerged, raising a set of discussions about twentieth-century flooding.

The asphalt layer we can see in São Paulo today was not the first waterproof cover set up to prevent the penetration of water into the soil. The city's entire stratigraphy is a complex maze of walls, floors, compacted layers, surfaces, deposits, and refuse which often reach great depth and are referred to disparate chronologies.

While the waterproofing of São Paulo did not start in the twentieth century, its peak probably corresponded with the 1960s. It compromised the hydrological cycle of more than one water reserve. River channelings altered flood components, requiring various disciplinary measures that altered the city's physical profile. Straight lines and angles emerged, as opposed to meanders and curves (Stuermer 2008). Channelings, straight lines, and acute angles materialized a new city to be disciplined (Rago 2014). The floods, on the other hand, materialized the irony that, even when they appeared to be subjected to the will of the modern city, they nonetheless retained a certain risky, unpredictable character (Edeworth 2011).

The history of the São Paulo floods from the late nineteenth century is one of continuing destructive effects and of their causes. In the eighteenth and nineteenth centuries, rainy season overflow had caused inhabitants innumerous inconveniences, such as blocked road; but, as the city still had its dry hills and preserved the floodplains of its main brooks, few actual "catastrophes" took place (Jorge 2011). It was the industrial city, with its promises of doing away with the unplanned disposition of used waters, that caused illnesses, becoming a health issue of grave concern, with the dominant elite's discourses eventually materializing into a sanitary urban landscape of roads (Custódio 2004). This was exemplified by engineer Prestes Maia's avenue plan of the 1930s. Prestes Maia envisaged the city as a structure which failed to accommodate its actual number of inhabitants at the time, and so he proposed a system of perimeter streets to use the margins of the great rivers as avenues (Rolnik 2003).

The plan went hand in hand with the building of a new landscape for São Paulo, which betrayed very clearly the tensions between humans and the environment. The history of the river Tamanduateí is a good example of the conflicts over its hydric regime and once-meandering contours. Fishing on the river was banned from the

Fig. 7.2 Itororó brook, currently May 23rd Ave

nineteenth century, prior to its channeling and the implantation of Do Estado Avenue on its margins. The same process was inflicted on Pinheiros River with the Pinheiros Highway and the Tietê River and the Tietê Highway. As is also well known, though, the rectifying and channeling projects themselves caused floods to increase, increasing disease levels.

The city's habitability was rendered precarious through the adoption of different measures which, ironically, were calculated to guarantee it; thus urbanization increased the hazards that threatened the viability of urban life itself (Simone 2016). With the avenue and urbanization plan, less affluent sectors of the population were pushed to the floodplains, rivers, and brooks, weaving a web of poverty in risk areas and the periphery (Jorge 2011). Living on the old floodplains, these populations were very directly affected by the negative effects of floods upon urban space.

To name a few watercourses turned into streets: July 9th Ave: Saracura Riverside; Jucelino Kubitschek Ave: Sapateiro Brook; Anhangabaú Valley: Anhangabaú Riverside; May 23rd Ave: Itororó Brook; Tietê Highway; River Tietê, Pinheiros Highway: Pinheiros River; do Estado Ave: Tamanduateí River; March 25th Street: Tamuandateí floodplain); Radial Leste Ave: Moringuinho Brook; Sumidouro Street: Sumidouro Brook. The Light & Power Co., responsible for most of the channelings and road-building over rivers, did little to combat the floods of the rivers it rectified, but rather increased it to catastrophic proportions by creating deficient urban draining and waterproofing (Fig. 7.2).

Fishermen had almost already disappeared by the 1930s, or at least no longer carried out their activities, as the modern city does not allow fishing and prosecutes it fiercely. Fishermen no longer had a place in the city, which violently rejected them. This is perhaps the most archaeologically visible aspect of the relationship between city, fishing and water: the complex, yet monotonous, stratigraphic profiles. We often find and excavate so many layers, so many floors, so many landfills, but only seldom do we ask ourselves about the meaning of these profiles. What sense can we make of Harris matrixes, for example?

Archaeological research carried out in the city of São Paulo has shown that the type of urban design deployed from the late nineteenth century took the ideas of landfilling and pavement beyond their mere immediate function in the realm of civil construction. It gave landfills a symbolic dimension and a central value in modernity projects. Landfills became a way of burying, erasing, and causing the disappearance of materialities which were no longer wanted; at the same time, landfills were a way of banning, inhibiting, and persecuting those who were considered undesirables. It is no coincidence that we bury rubbish. To lay pavement and to waterproof became unstoppable ends.

When we consider one of the things we are best at, excavation, we take a deeper look at the question of urban-soil waterproofing. Layers and urban stratigraphy can be used to read beyond mere questions of occupational sequence, or of the domestic consumption of certain materials. We can look at these layers and show how waterproofing policies will inevitably be ineffective unless they go beyond the present surface. Landfills, floors, other constructions, and their stratigraphic superimposition make up a barrier through which water cannot possibly circulate, but rather remains flooded on the surface, creating currents which drag everyone and everything along with them. It thus becomes evident that the city is the "cumulative result of all the other previous cities, transformed, destroyed, reconstructed, produced by social transformations occurring overtime, and brought about by the relationships which promote those transformations" (Sposito 2000).

All of these transformations have a tremendous impact on the water cycle on the plateau. In contrast to the uncontrolled floods of the nineteenth century, the twenty-first century is experiencing a severe draught combined with water overuse. While the public powers did not take the necessary measures immediately, by building dams and contributing to the near death of those rivers and not renewing phreatic sheets with percolated waters, they materially contributed to the growth of the city's hydric crisis, a chronic problem which environmentalists have been denouncing since at least the early 2000s. As we become used to droughts and water shortages, our memories of fishermen become even more remote.

How then can archaeology go against the grain of this gradual physical and social disappearance of fishermen? The roughness of the fishing trade and of its relationships with rivers is there for attentive eyes to see, visible in the ways the city materially expressed itself against fishermen. The surface bears its own roughness ties: a clock tower in the neighborhood of Jaguaré, at the point where the Tietê and Pinheiros rivers meet, which is in fact a 1930s lamp post; several of the city's blocks bear strange, narrow, and tortuous streets which contrast the straight lines of certain neighborhoods—

Fig. 7.3 Map of the S. Paulo city, 1924 (Emídio and Passos 2009). Detail of flooded areas around the Pinheiros river, with potteries and a fluvial port

they were once old brooks but today are small, cemented rivers (Bertalini 2014). Merely walking around the city, especially around the floodplain neighborhoods, can reveal the material solutions created by local people to avoid floods and droughts: low brick walls, mini-floodgates, pumps, and a number of material devices, all attest to the ways in which water has transformed the city over the past few years.

It is worth remembering the several fluvial ports along these many rivers which were used to navigate them at least until the 1950s, transporting commodities and people (Bava de Camargo 2004). The Veloso fluvial port, at the end of today's Paes Leme Street in Pinheiros neighborhood, had already been destroyed by tram-works in the early twentieth century. The port was also for the commercial production of ceramics and to moor ships registered at the town hall, which once sold catfish, tied by the gills to the lianas and sent to the region's country markets (Zanettini Archaeology 2011). The José Florêncio port, a mere kilometer away from the station of Osasco, was fundamental in the communication between enveloping neighborhoods, and witnessed frequent swaps in the ferries responsible for water transportation (*Correio Paulistano* [1903], 12 June, p. 2). It is also well known, on the other hand, that as well as the official ports, countless docking spots existed on either side of Paulista upland rivers, in view of the many references to boats and canoes. Historical cartography constitutes a rich source for them, as attested by the following example, which associates potteries (*olaria*), flooded areas (*alagado*), port (*pto*), and rivers in the 1924 (Emídio and Passos 2009) (Fig. 7.3).

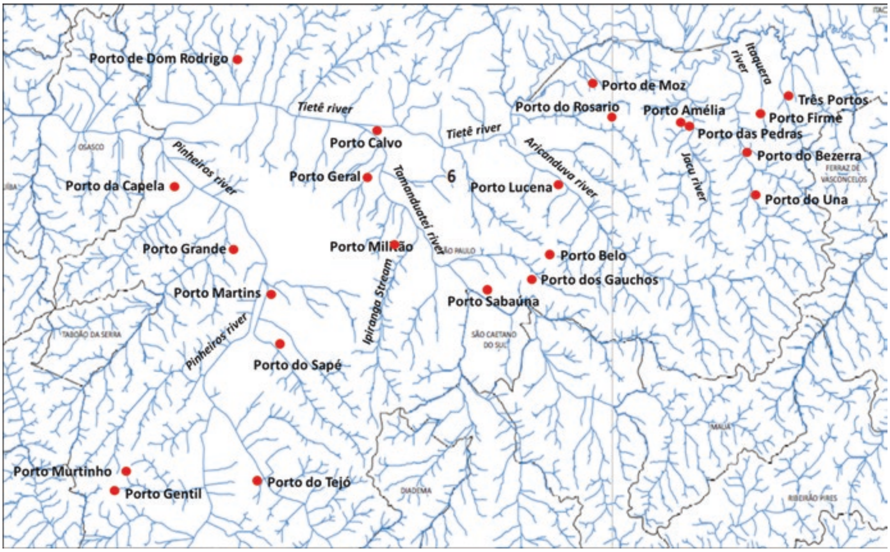

Fig. 7.4 Streets with ports' names in relation to São Paulo hydrography. Base: Projeto Rios (in) visíveis, 2017

Urban toponymics also allows us to access that concrete world. One of the most evident toponyms is the Pari neighborhood, named after the much-maligned indigenous technique, which was nonetheless taken up by its fishing community. The Rua dos Pescadores (Fisherman's Street), in the Cambuci neighborhood, nowadays distant from the margin of the now rectified river Tietê, used to embrace a fishing community. Água Rasa (Shallow Water), Água Funda (Deep Water), Água Branca (White Water), Água Fria (Cold Water), and Jardim Pantanal (Swamp Garden) are some of the neighborhood names that illustrate the water's importance and its relation to São Paulo's urbanization.

A search for streets names in the city (Dicionário de Ruas de São Paulo, 2016) reveals that those who have in their names the word *port* (porto) are coincidentally placed near rivers cutting through the urban site—it would seem logical that they should refer to the old locations of fluvial points. The well-known Ladeira Porto Geral-General Port Slope, in the city center, retains the name of the refined port of Tamanduateí, at March 25th Street. We can also mention the streets Porto Calvo, Porto Militão, and Porto Sabaúna (all connected to the river Tamandateí); Porto Belo and dos Gaúchos (associated with the Tatuapé brook); Porto Lucena (associated with the Aricanduva river); Porto Amélia and Porto das Pedras (associated with the river Jacú); Porto do Bezerra and do Una (associated with the river Itaquera and its tributaries); and Porto Firme and Três Portos (associated with the brook of Cruz Negra). The map below shows the relationships between streets with port names and the hydrographic network that runs through channels or tubes below the avenues (Fig. 7.4).

The hydric crisis and droughts have also altered the urban landscape through the proliferation of urban art portraying water, or lack thereof, whether referring to

Fig. 7.5 Zezão's graffiti representing water coming from the beneath the sidewalk at Oscar Freire Street and Cardeal Arco Verde Street, under which runs the Green Brook

droughts, floods, or to the absence of subterranean rivers. Some graffiti represents water in places where brooks used to run, or water springs suffocated by the urban grid, "creating" a water that no longer exists (as does the work of graffiti artist Zezão).[2] All these expressions indicate a camouflaged existence in a city whose materiality has been designed to hide water courses. It also portrays the violence which the city has used in causing certain social sectors to disappear by destroying their landscapes. Fishermen, are a good example, condemned to oblivion and removed from people's memories—with no remorse—by a material configuration which makes it seem absurd that they might even have existed. (Fig. 7.5).

7.4 Sous les Paves, la Plage

Mullets, whiting, grouper, minnows, wolf fish, catfish, pothole shovelnose, catfish, prawns, crabs, mussels, and frogs. In the state of São Paulo fishing established a discourse with food on the Paulista uplands and with rivers as places for socialization and interaction. An increased demand for fish and the lack of foresight by ferociously hygienic urban planners—which, in the name of modernity and civilization caused the overexploitation of fishing resources. Aggressive techniques were put into place by artisanal fishermen themselves, turning traditional techniques into

[2] In January 2016, recently elected São Paulo Mayor, João Dória, officially ordered the coverage of all graffiti with gray ink and declared a war against graffiti and its authors.

technologies of modernity, caught themselves in the trap of a cruel modernity which forced them to remorseless self-cannibalism. Hygienic policies brutally attacked the open-air street sale of fish and, thus, the practices of those who obtained and sold fish.

The aggressiveness of this materiality was exemplified by the demolition of the "infectious" fish market on March 25th Street, which was seen by many as nothing but trouble. This demolition was acclaimed as having put an end to "nothing but a slum in the capital," by the Hunting and Fishing Service in 1928 (*Diário Nacional* [1928a], 03 March, p. 1). Increased water pollution and rectifying and channeling of drains had a very important part in undermining the resilience of fluvial aquatic ecosystems on this portion of the Tietê river basin. São Paulo is a material example of how excessive action can cause a drastic decrease in fishing stocks and the decline of artisanal fishing, an apocalyptic diagnosis which nonetheless repeats itself in ethnographies across the country (Aguiar et al. 2001)

Looking at the city of São Paulo, we see that archaeology can contribute to a more creative reading of already long known contexts by archaeologists themselves: a different reading of paulistanian materiality caught up in a critical gaze at the life we lead in the city today, one which seeks to understand the processes by which the city of São Paulo became what it is also by destroying (Berman 1983). The city is itself the genealogy of its own destruction.

The feeling of walking along the side of the rivers Tietê, Tamanduateí, and Pinheiros must have been completely different from that of strolling along the Tietê Highway, Pinheiros Highway, and the Do Estado Avenue—very inadvisable, by the way. Canoes and other boats made river traffic livelier, amid fishermen who, individually or in groups, fished by the drains. Sand banks were used as river beaches. Later, yachting and canoeing clubs began to use rivers for training. Washerwomen washed their clothes in brooks and lakes.

Investigating the genealogy of destruction and construction in São Paulo, archaeology can bring forth groups which are little known today, who have left very sparse or no material records, and few written records. Their narratives take us away from the dangers of single stories (Adichie 2009). As archaeologists, we can also have a more active role in discussions about urban sustainability, by revealing the ways in which past, materialized as waterproofing, for example, has had an impact on the present.

Waterproofing in the city of São Paulo is a modern technology with an environmental dimension, but also a social one which affects rivers and fishermen, who are placed on the margins and then forced to disappear. In an almost literal way, archaeology allows us to live the May 68 utopia: finding the beach beneath the pavement, fishermen beneath concrete—novelty, freedom, rebellion.

The frequent unearthing of simple fishing-net weights on archaeological sites in the city of São Paulo proves that disappearance and highlights both the changes undergone by the city and the way in which these took place. The channeling of rivers and the entire materiality presently characterizing the whole drain system of basins and mini-basins of the uplands are also related to abrupt changes in ways of life, of obtaining sustenance, and of the social reproduction of certain social groups, which eventually disappeared. Washerwomen and fishermen were suddenly forced to seek alternatives as practitioners of a craft which had become obsolete in established modernity. They were forced to use the resources necessary to their trade to exhaustion and thus eventually assist in their own demise.

This cruel modernity banned from memory all traces of fishermen, about whom it is so difficult to find out anything at all—so difficult that his text had to be based largely on material, written, toponymic, cartographic and iconographic sources combined. Universal discourses of modernity took the destruction of these ways of life in an almost natural way, justifying it in favor of a better future (Lawrence 1997). Modernity in Latin America has brought about many other types of disappearance through a number of different strategies. Archaeology can help us examine the vestiges of that cruelty.

Finally, waterproofing can be used as a metaphor to highlight the way in which the archaeology of modernity and of the contemporary past reveals, beneath the concrete of capitalism, other histories and experiences which become available by the use of a more permeable archaeology. It also shows the ways in which an archaeology of the contemporary past can be approached in Latin America, in a dialogue with the creation of particular-interest focuses and critical approaches to the construction of archaeological, anthropological, and historic knowledge (Jimeno 2004; Dillehay 2009). Observing the recent past from an archaeological perspective allows us to rethink modernist temporalities and transgress the established chronological frameworks of conventional and dominant Anglo-Saxon archaeology (Politis 2005; González-Ruibal 2014).

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References

Ab'Saber, A. (2003). *Geomorfologia do sítio urbano de São Paulo*. São Paulo: Edusp.

Abreu e Souza, R. (2013). Contribuição da arqueologia urbana à compreensão dos desastres naturais paulistanos: enchentes e impermeabilização do solo urbano. *Revista Eletrònica História e-História*. Retrieved from http://historiaehistoria.com.br

Adichie, C. (2009). The danger of a single story. [YouTube]. *Project: TED Talk*. Retrieved from https://www.ted.com/talks/chimamanda_adichie_the_danger_of_a_single_story

Aguiar, R., et al. (2001). A pesca artesanal na praia do Pântano do Sul, Brasil. *Revista de Ciencias Humanas, 29*, 141–157.

Almeida, G. (2004). *Pela cidade*. São Paulo: Martins Fontes.

Bartalini, V. (2014). Córregos em São Paulo: a ocultação do avesso. *Geograficidade, 4*(1), 30–37.

Bava de Camargo, P. (2004). O Itaim já foi porto. *Historia e-Historia*. Retrieved from https://www.historiaehistoria.com.br

Benchimol, J. (2003). Reforma urbana e revolta da vacina na cidade do Rio de Janeiro. In J. Ferreira & L. Delgado (Eds.), *O Brasil republicano* (pp. 233–278). Rio de Janeiro: Civilizacao Brasileira.

Berman, M. (1983). *All that is solid melts into air*. New York: Verso.

Bertucci-Martins, L. (2003). Conselhos ao povo: educação contra a influenza de 1918. *Cadernos Cedes, 23*(59), 103–117.
Bicudo, C. E. M., Tundisi, J. G.; & Sheuenstuhl, M. C. B. (2010). *Águas do Brasil: análises estratégicas*. São Paulo: Instituto de Botânica.
Blaj, I. (2002). *A trama das tensões*. São Paulo: Edusp.
Briggs, J. M., et al. (2006). Why ecology needs archaeologists and archaeology needs ecologists. *Front Ecological Environment, 4*(4), 180–188.
Bruno, E. S. (1953). *História e tradições da cidade de São Paulo* (Vol. 2). São Paulo: J. Olympio.
Buchli, V and Lucas, G. (Org.). (2001). *Archaeologies of Contemporary Past*. London: Routledge.
Carvalho, V. (2008). *Gênero e artefato*. São Paulo: Edusp.
Chalhoub, S. (2006). *Cidade Febril*. São Paulo: Cia das Letras.
Cole, S. (2009). Dynamite violence and literary culture. *Modernism/modernity, 16*(2), 301–328.
Correio Paulistano. (1865). supplement to n. 2767. Digital Periodic Library. National Library Archive.
Correio Paulistano. (1869). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1874). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1880, March 12). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1885a, September 11). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1885b, September 22). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1885c, March 27). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1889). Digital Periodic Library. National Library Archive
Correio Paulistano. (1891, January 11). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1899a, May 13). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1899b, July 21). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1903, June 12). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1904, September 27). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1906, December 20). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1909a, January 25). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1909b, October 27). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1910, August 20). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1936, December 20). Digital Periodic Library. National Library Archive.
Correio Paulistano. (1942, May 6). Digital Periodic Library. National Library Archive.
Custódio, V. (2004). Dos surtos urbanísticos do final do século XIX ao uso das várzeas pelo plano de Avenidas. *Geosul, 19*(38), 77–98.
D'Agostini, A. (2013). Colaboração do Sr. Antonio Fidencio D'Agostini, pertencente a família de imigrantes italianos que se estabeleceram no local em 1889. Retrieved from http://historias-dopari.wordpress.com.
Diário Nacional. (1928a, March 03). Digital Periodic Library. National Library Archive.
Diário Nacional. (1928b, August 31). Digital Periodic Library. National Library Archive.
Diário Nacional. (1931, November 18). Digital Periodic Library. National Library Archive.
Dicionário de Ruas de São Paulo (2016). Retrieved from http://www.dicionarioderuas.prefeitura.sp.gov.br/
Dillehay, T. (1996). *Monuments, Empires, and Resistance: The Araucanian Polity and Ritual Narratives*. Cambridge: Cambridge University Press.
Dillehay, T. (2009). Latin American archaeology in history and practice. In A. Bentley, H. Maschner, & C. Chippindale (Eds.), *Handbook of archaeological theories* (pp. 165–185). Lanham: AltaMira Press.
Diniz, J. (2013). Representações do Tietê na historiografia paulista. *Revista Latino-Americana de História, 2*(8), 126–140.
Duarte, L. (1999). *As redes do suor*. Rio de Janeiro: Eduff.
Edgeworth, M. (2011). *Fluid pasts: Archaeology of flow*. London: Bristol Classical Press.
Emídio, T., & Passos, M. L. P. (2009). *Desenhando São Paulo*. São Paulo: IMESP.
Eremites de Oliveira, J. (1996). *Guató: argonautas do Pantanal*. Porto Alegre: Edipucrs.
Fabian, J. (1983). *Time and the other*. New York: Columbia University Press.
Foucault, M. (1971). Orders of discourse. *Social Science Information, 10*(2), 7–30.

Franco, J. (2013). *Cruel modernity*. Durham: Duke University Press.
Giddens, A. (1991). *The consequences of modernity*. Cambridge, UK: Polity Press.
González-Ruibal, A. (2008). Time to destroy: An archaeology of supermodernity. *Current Anthropology, 49*(2), 247–279.
González-Ruibal, A. (2012). Hacia otra arqueología: diez propuestas. *Complutum, 23*(2), 103–116.
González-Ruibal, A. (2014). Archaeology of the contemporary past. In C. Smith (Ed.), *Encyclopedia of global archaeology* (pp. 1683–1694). New York: Springer.
González-Ruibal, A., & Hernando, A. (2010). Genealogies of destruction: An archaeology of the contemporary past in the Amazon Forest. *Archaeologies, 6*, 5–28.
Gouveia, I. C. (2016). A cidade de São Paulo e seus rios: uma história repleta de paradoxos. *Confins*, *27*. https://doi.org/10.4000/confins.10884
Harrison, R. (2011). Surface assemblages. Towards an archaeology of the present. *Archaeological Diologues, 18*(2), 141–161.
Heckenberger, M., & Neves, E. (2009). Amazonian archaeology. *Annual Review of Anthropology, 38*, 251–166.
Heizer, R. F. (1986). Venenos de pesca. In D. Ribeiro (Ed.), *Suma etnológica brasileira* (Vol. 1, pp. 189–233). Rio de Janeiro: Vozes, FINEP.
Isabel (Princess of Brazil). (1957). *Diario da Princesa Isabel (Excursão dos Condes d' Eu à Provincia de São Paulo em 1884)*. Anhembi: Sao Paulo.
Jimeno, M. (2004). La vocación critica de la antropología latinoamericana. *Maguaré, 18*, 33–58.
Jorge, D. (1942, May 6). O bairro do Pari. *Correio Paulistano*, p. 2. Digital Periodic Library. National Library Archive.
Jorge, J. (2006). *Tietê, o rio que a cidade perdeu*. São Paulo: Alameda.
Jorge, J. (2011). São Paulo das enchentes, 1890-1940. *Histórica, 47*, 1–7 Retrieved from http://www.historica.arquivoestado.sp.gov.br/materias/anteriores/edicao47/materia01/.
Jorge, J. (2012). Rios e saúde na cidade de São Paulo, 1890-1940. *História & Perspectivas, 24*, 103–124
Juliani, L. (1996). *Gestão arqueológica em metrópoles: uma proposta para São Paulo* (Master dissertation). Available Biblioteca Digital de Teses e Dissertações da USP.
Koguruma, P. (1999). A saracura: ritmos sociais e temporalidades da metrópole do café (1890–1920). *Revista Brasileira de História, 19*(38), 81–99.
Lawrence, P. (1997). *Modernity and war*. London: Palgrave Macmillan.
Lucas, G. (2004). Modern disturbances: on ambiguities of archaeology. *Modernism/modernity, 11*(1), 109–120.
Marengo, J. A. & Alves, L. M. (2016) Crise hídrica em São Paulo em 2014: seca e desmatamento. *Geousp, 19*(3), 485–494
Martinelli, M. (2006). *Antônio Callado, um sermonário à brasileira*. São Paulo: Annablume.
Mercantil, O. (1891, January 13). Digital Periodic Library. National Library Archive.
Normark, J. (2014). Water as hyperfact. *Current Swedish Archaeology, 22*, 183–206.
Okano, T. L. (2007). *Verticalização e modernidade: São Paulo 1940-1957*. (Master dissertation). Availale in Biblioteca Digital Universidade Presbiteriana Mackenzie.
Oliveira, M. L. F. (1999). O registro dos limites da cidade: imagens da várzea do Carmo no século XIX. *Anais do Museu Paulista, 6/7*, 37–59.
Oliveira, A. (2005). Um estudo em arqueologia urbana: *a carta de potencial arqueollógico do centro histórico de Porto Alegre*. (Doctoral dissertation). Pontifícia Universidade Católica, Porto Alegre. CD-Room.
Oliveira, J. (2007). A pesca e os pescadores: recursos naturais e conflito social. In P. H. Martinez (Ed.), *História ambiental paulista* (pp. 119–132). São Paulo: Senac.
O Mercantil. (1890). Digital Periodic Library. National Library Archive.
Il Pasquino. (1922). Digital Periodic Library. National Library Archive.
Pinto, M. I. M. B. (2002). *Encantos e dissonâncias da modernidade: urbanização, cinema e literatura em São Paulo*, 1920-1930. Available in Biblioteca de Teses e Dissertações da USP.
Politis, G. (2005). Latin American archaeology: An inside view. In B. Alberti & G. Politis (Eds.), *Archaeology in Latin America* (pp. 1–13). New York: Routledge.
Prado, C. (1953). *A cidade de São Paulo, evolução política e outros ensaios*. São Paulo: Brasiliense.

Projeto Rios (in)visíveis. (2017). Retrieved from http://www.riosdesaopaulo.org/
Queiroz, R. (2015). Visibilidade e protagonismo dos pescadores e pescadoras do Brasil. *Extramuros, 3*(2), 244–250.
Rago, L. M. (2014). *Do cabaré ao lar*. Rio de Janeiro: Paz e Terra.
Ramalho, C. W. N. (2014). Estado, pescadores e desenvolvimento nacional. Da reserva naval à aquícola. *Ruris, 8*(1), 31–62.
Rebouças, F. (2013). Pesca explosiva. *Infoescola*. Retrieved from http://www.infoescola.com/economia/pesca-explosiva/
Rodrigues, C.; & Villela, F. N. J. (2016). Disponibilidade e escassez de água na Grande São Paulo: elementos-chave para compreender a origem da atual crise de abastecimento. *Geousp, 19*(3), 399–421
Rolnik, R. (2003) *São Paulo*. São Paulo: Publifolha.
Saint-Hilaire, A. (1967). *Viagem à província de São Paulo*. São Paulo: Martins.
Sampaio, M. R. A.; & Pereira, P. C. X. (2003). Habitação em São Paulo. *Estudos Avançados, 17*(48), 167–183.
Sant'Anna, D. (2007). *Cidade das águas*. São Paulo: Senac.
Santos, M. (2004). *Por uma geografia nova*. São Paulo: Edusp.
Santos, F. A. (2011). A invasão das águas ou as águas invadidas? Construção social e econômica das enchentes na cidade de São Paulo (1875–1963). In *Anais do XXVI Simpósio Nacional de História*. São Paulo: ANPUH.
Santos, M. (2012). *A natureza do espaço*. São Paulo: Edusp.
Sautchuck, C. (2007). *O arpão e o anzol: técnica e pessoa no estuário do Amazonas (Vila Sucuriju, Amapá)* (Doctoral dissertation). Available Repositório UnB database.
Schwarcz, L. M. (1993). *O espetáculo das raças*. São Paulo: Cia das Letras.
Sevcenko, N. (1992). *Orfeu extático na Metrópole*. São Paulo: Cia das Letras.
Sevcenko, N. (2004). A cidade metástasis e o urbanismo inflacionário: incursões na entropia paulista. *Revista USP, 63*, 16–35
Silva, E. (2014). *O rio, a cidade e o processo de urbanizacao* (Graduate dissertation). Available from (USP).
Simone, A. (2016). The uninhabitable? In between collapsed yet still rigid distinctions. *Cultural Politics, 12*(2), 135–154.
Sposito, M. (2000). *Capitalismo e urbanizção*. São Paulo: Contexto.
Stuermer, M. (2008). Renaturalização de rios e córregos do município de São Paulo. *Exacta, 6*(1), 147–156.
Taunay, A. (2004). *História da cidade de São Paulo*. Brasília: Senado Federal.
O Ypiranga. (1867). Digital Periodic Library. National Library Archive.
Zanettini Archaeology. (2009). *Programa de Resgate e Monitoramento Arqueológico—Casa Bandeirista do Itaim Bibi. Final Report*. São Paulo: Zanettini Arqueologia.
Zanettini Archaeology. (2011). *Programa de Resgate Arqueológico Sítio Arqueológico Pinheiros 2. Final Report*. São Paulo: Zanettini Arqueologia.
Zanettini, P. E. (2005). *Maloqueiros e seus palácios de barro: o cotidiano doméstico da Casa Bandeirista* (Doctoral dissertation). Available from Biblioteca de Teses e Dissertações da USP.
Zanettini, P. E., & Wichers, C. (2009). A cerâmica de produção local/regional em São Paulo colonial. In W. Morales & F. Moi (Eds.), *Cenários regionais em Arqueologia Brasileira* (pp. 311–334). Porto Seguro: Annablume.
Zarankin, A., & Senatore, M. X. (2007). *Histórias de uma pasado en blanco*. Belo Horizonte: Argumentum.

Chapter 8
Entangled Relations: The Expansion of a Colonial Frontier in Central Brazil During the Eighteenth Century

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Abstract This chapter aims to examine the process of colonial expansion in one of the fringes of Portuguese America. A pioneer area of occupation in Central Brazil during the eighteenth century, which included villages, mining areas, plantations and runaway slaves' settlements, will be analyzed. While investigating the process of gradual expansion of the colonial frontier in this area, we will discuss the interactions between different inhabitants and how they became entangled. Particular emphasis will be given to how these entanglements are related to the construction of power and ethnicity. Discussions will be drawn from actor–network theory (ANT). Three concepts derived from this theory will be instrumental in our analysis: agency, affordance and translation. In order to go beyond the study of the "social landscape," which focuses on the human and social components of the landscape and has been the dominant perspective of analyses in historical archaeology, we will systematically consider non-human components in our discussions.

8.1 Introduction: An Archaeology of the Interaction Between People and Things

In the last quarter of the seventeenth century, the economic and social life in Portuguese America experienced a great change. The discovery of gold in the Brazilian interior made the Portuguese Crown's activities concentrate on this region. After successive discoveries in Minas Gerais (1680), Mato Grosso (1719) and Goiás (1725), gold produced great wealth for Portugal and pushed the limits of the colony toward the west. This chapter discusses the expansion of rural units in the

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pioneering area of occupation in Goiás, Central Brazil, during the initial moments of that time period. More specifically, we analyze an area located to the south of a mountain called Serra Dourada. This region was occupied during the colonial period, from the second quarter of the eighteenth century onward (Fig. 8.1). Considering the complexity of the occupation, we limit our discussions to the first years of this process, between 1726 and 1765.

In our analysis, we intend to go beyond the so-called social landscape. Studies with this focus, which tend to be dominant in historical archaeology, usually consider the human and social components of the landscape. Here we adopt a different approach by taking into account the environmental components that were deeply involved in its constitution. It is our intent to demonstrate that the difference components of this landscape—human and nonhuman—were entangled. Our starting point for this discussion is based on the understanding that environment is not merely a backdrop, a neutral space open to human appropriation. Instead, we consider that all entities that exist in it—forests, soils, minerals, waters, land formations, and so on—are *participants* in the constitution of the landscape (Latour 2005, pp. 70–74).

Discussions draw upon some of the most fundamental postulates of the actor–network theory (ANT). We seek inspiration mainly from the discussions about the interactions between different types of entities, as presented by Callon (1986) and Latour (1999, 2005). Three related concepts are taken into account. The first is the concept of *agency* that, as understood from the perspective of ANT, goes beyond the "intentional world" of humans. We base our interpretation on the perception of Latour (2005, p. 71) that "any thing that modifies a state of affairs by making a difference is an actor." Through this understanding we hope to expand our repertoire of possibilities, as we consider other agents and agencies, beyond the human ones. The second concept, which largely derives from the first, is *affordance*. This concept comes from the idea that all things offer a number of possibilities on the one hand, while at the same time restricting others, thereby guaranteeing their participation in specific types of action, whenever they are requested by other actors (Latour 2005, pp. 71, 72). We consider this concept in order to map modes of interaction that took place between humans and nonhumans, as well as the consequent networks that they created. We consider that all things have potential qualities and competencies, which can be activated or not, depending on the type of interaction that is taking place. In this sense, the results of certain agencies are variable and depend on the ongoing interaction. Finally, we consider the concept of *translation*, understood as the process in which networks are constituted. These processes may include associations among ideas, things, individuals and resources, and have as a result the formation of alliances involving different types of entities (Callon 1986; Latour 1999, pp. 24–79). As pointed out by Callon (1986, p. 224), "translation is the mechanism by which the social and natural worlds progressively take form."

To carry out these discussions we combine analyses of documentary, environmental and archaeological data. We consider in greater depth a particular type of document: the *sesmarias* records, which were examined in three different public archives offices.[1] The sesmarias were portions of land granted by the Portuguese

[1]Arquivo Histórico de Goiás (AHG); facsimile copies from the documents existentent in Arquivo

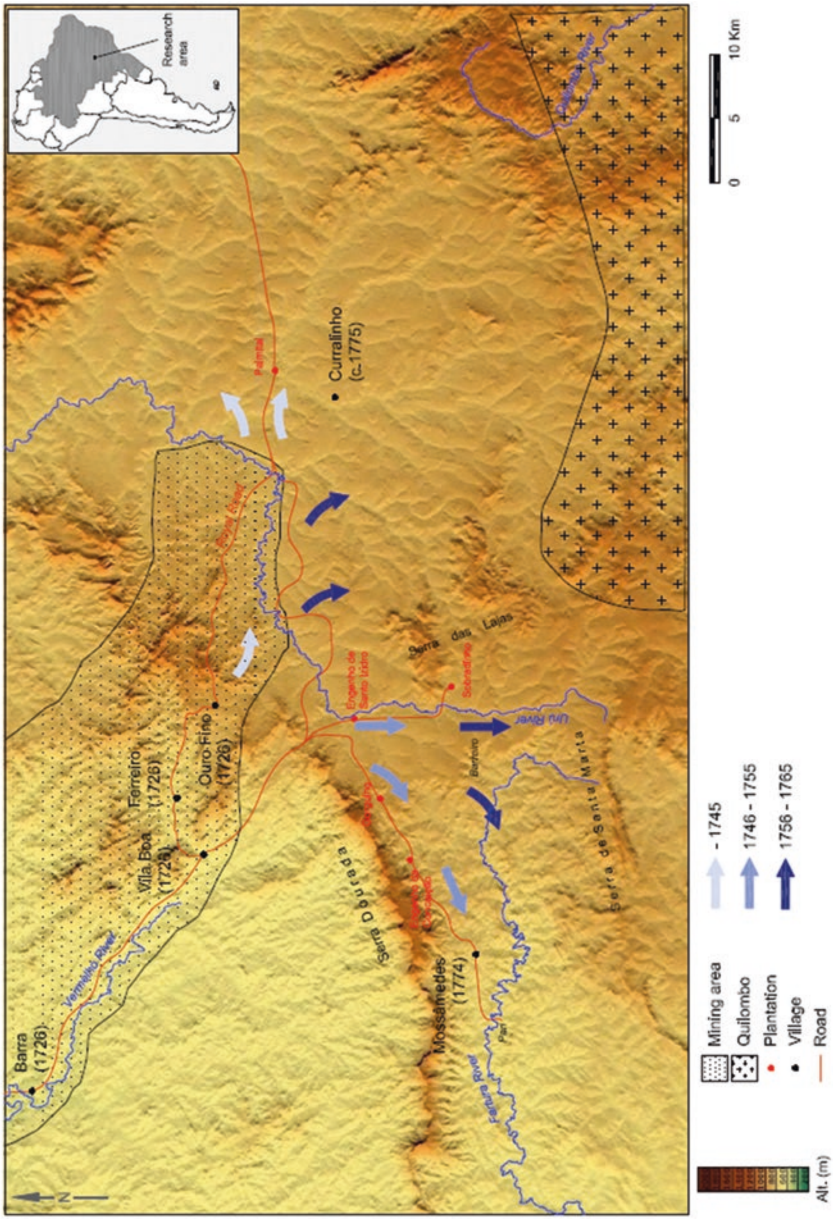

Fig. 8.1 Map showing the places mentioned in this chapter

Crown to individuals with the objective of stimulating food production and territorial possession. Information available in these documents includes details about the intended location, size and purpose of the land. Despite the fact that not all land recipients who solicited sesmarias occupied the land that they requested, they offer important clues about the process of colonial expansion in a given area. These data are complemented with other types of information and are used to understand the history of land use in the area. Environmental data include geological, geomorphological and pedological dimensions, all of which are summarized in Figs. 8.2, 8.3, and 8.4. In addition, we consider information about vegetation in some of the locations under study. Finally, archaeological data include information about some of the sites located in this particular area.

8.2 The Process of Colonial Expansion

8.2.1 From 1726 to 1745

The beginning of mining activity in Brazil can be traced back to the discovery of alluvial deposits of gold identified in Minas Gerais in the seventeenth century. There was a massive involvement of colonizers and enslaved Africans in the mining endeavor, whose technical knowledge possibly contributed to the profiteering of this mineral (Silva 1995). The occupation of Goiás began shortly thereafter. The colonial presence in Goiás was established in 1726 after an expedition that started in São Paulo and that was led by Bartolomeu Bueno da Silva, who discovered auriferous streams near the sources of Vermelho River. With the title of superintendent of the mines of Goiás, granted by the Portuguese crown, he founded the first villages in that region: Sant'Anna (later Vila Boa and Goiás City), Ferreiro, Ouro Fino and Barra (Fig. 8.1). In the areas surrounding these villages, the first mining zone was created, whose limits may be inferred from documentary sources (Bertran 1997a, pp. 107–111).[2]

The main hypothesis for the discovery of gold in the area considered here is directly linked to geological dimensions, as well as the relationships that were established among different elements, including rocks, secondary deposits and the landscape compartmentation. This mining zone was associated with the metaconglomerate present in the Serra Dourada group (*Grupo Serra Dourada*). In this segment there was an abundance of quartzite and metaconglomerate from Goiás Velho Group (*Grupo Goiás Velho*) and Serra do Cantagalo Sequence (*Sequência Serra do Cantagalo*), both containing gold (Fig. 8.2). Since the auriferous metaconglomerate existent in the region is part of the substrate where the pioneer villages were estab-

Histórico Ultramarino (AHU) at the Instituto de Pesquisas e Estudos Históricos do Brasil Central (IPEHBC); and Procuradoria Geral do Estado de Goiás (PEG).

[2] See also "Mapa de Vila Boa de Goiás e tudo o mais que pertence a seu termo," unknown author, 1758.

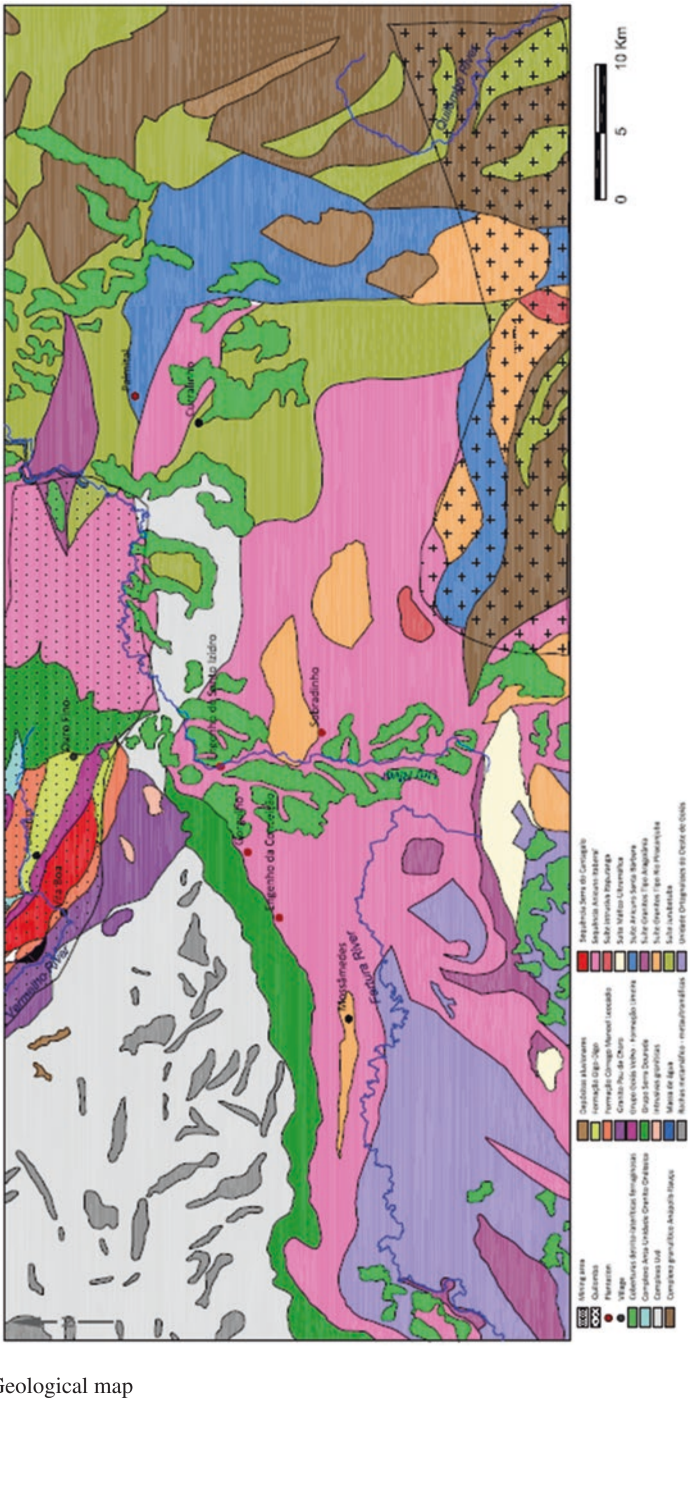

Fig. 8.2 Geological map

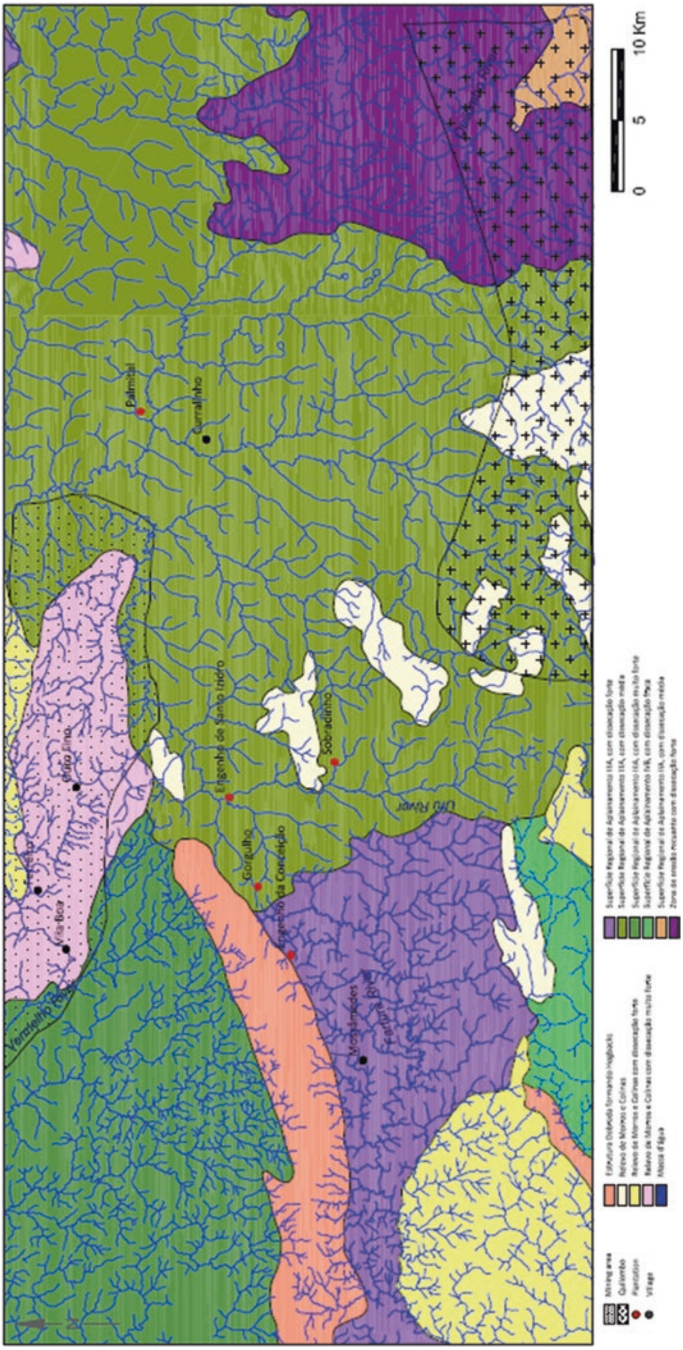

Fig. 8.3 Geomorphological map

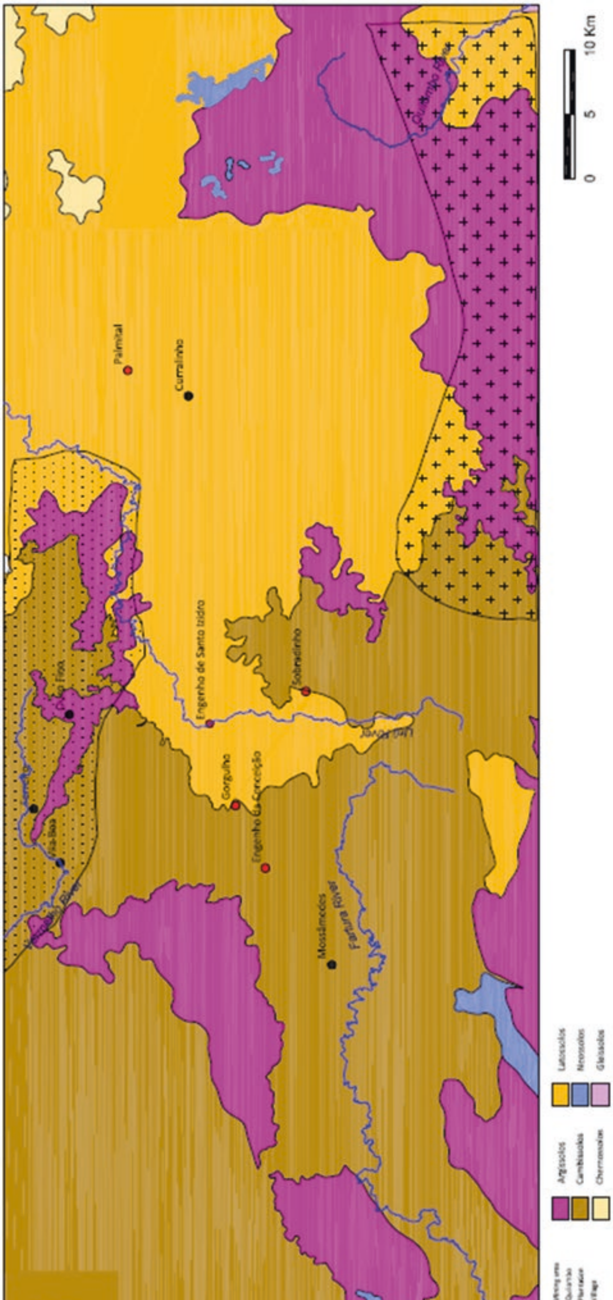

Fig. 8.4 Pedological map

lished, sometimes with occasional outcrops, it is likely that the identification of the mineral in this region has been possible due to its relation to the existing metaconglomerates. It is also worth noting that the exploration of this mineral was perhaps directed to the alluvions, which can be easily accessed for exploration purposes.

The compartmentation of the landscape may also have influenced the process of control and surveillance of portions of land for mining purposes. This is visible if the limits of the mining zone are considered. As can be seen in Fig. 8.2, part of what is known to be the Unity B (of the *Grupo Serra Dourada*) contains mineralized gold that is within the mining zone, located close to Ouro Fino, as well as the Unities from Goiás Velho Group and Serra do Cantagalo range, which are located close to Ferreiro and Vila Boa. The zone of gold exploration has a clear relation not only to the locations where mineralized rocks are present, but also to the presence of alluvial deposits.

With the influx of miners to this region, a trail and later on a road was created that was called Royal Road (*Estrada Real*) in order to connect the pioneer area of occupation to the major Brazilian provinces (Fig. 8.1). This initial development was characterized by a type of occupation that Rockman (2003, p. 10) called "point and arrow," which represents movements in which colonizers "stream" toward new areas, leaving the areas in between uncolonized and the new lands in relative isolation. This mode of occupation was characteristic of gold-mining areas in Brazil during the eighteenth century, when patches were formed around the activities. In such contexts, the epicenter could be considered the villages where the miners and enslaved Africans lived (Singer 1977, p. 200).

The first rural settlements in this region were established close to the pioneer villages and, especially, along the Royal Road. Before 1745, at least four land portions were requested, all of them located close to this road (Aguirra 1998, pp. 8, 9, 12; Bertran 1997b, p. 75),[3] and it is possible that undocumented smaller units were also created in their interstices. The plantation known as Engenho do Palmital dates from this period. This unit was devoted to the production of manioc flour and, especially, sugar-cane (Bertran 1997a, p. 116). This site, situated on the margin of the road (Fig. 8.1), was archaeologically identified. Like the other historical sites located in the region, there is no architectural evidence preserved above ground.[4]

The creation of rural units along the road was part of a practice stimulated by the Portuguese Crown that involved dotting the roads with settlements in order to guarantee places for resting and replenishing supplies for the travelers. As this locality became increasingly populated with such structures, an initial web of associations was created that included villages, mining zones, rural units and other settlements.

[3] See also: Pedido de confirmação de sesmaria de Margarida da Silva Bueno, AHU, IPEHBC, Cx.22, Doc.1348, 4.18.1766; Requerimento de Tomé da França Maciel, AHG, Cx.1, Pcte3, 1.30.1750[174?].

[4] According to Maria de Lourdes Espindola de Oliveira (personal information, September 16th, 2005), who was born in Palmital, this plantation was abandoned in the first half of twenty century.

8.2.2 From 1746 to 1755

After its initial phase, the occupation of the region followed a different pattern. It followed what Rockman (2003, p. 11) has called an “advancing front,” a process of expansion over a given territory involved relatively regular movements over short distances into areas adjacent to previously known ones. In these situations, the new area would be explored and learned through a combination of short-distance way-finding and substantial infilling before the next move is made.

This process of expansion on a territorial level soon reached the region at the South of Serra Dourada, taking two different directions. The first would take place between the foot of the mountains and the location where the village of Mossâmedes would be later established (Fig. 8.1).[5] Its occupation was stimulated by the discovery of gold in this locality. Documentary evidence suggests that this discovery was made by two members of the original expedition that arrived in Goiás in 1726: Baltazar de Godoi Bueno and Ignácio Dias Paes. Baltazar, son of Bartolomeu Bueno, was the *guarda-mór* of the mines of Vila Boa, and had the function of distributing and supervising the mines (Salgado et al. 1985, pp. 283–285). Ignácio was the son-in-law of Bartolomeu Bueno and occupied several administrative and military positions in the province (Moreyra 2015, p. 99).

When mining began at the foot of Serra Dourada, there were a number of rivers and streams with different degrees of potential for exploration. From the geological point of view, the metaconglomerate from the Serra Dourada Group (Unit B), that contains gold and diamond and that, according to the records, was not explored, has outcroppings which run in a northeast-southeast direction (Fig. 8.2), within a segment parallel to the Serra Dourada, This geological fact testifies to the mineral potential of the rivers and streams existent in the locality, especially those that are born in the mountains or are intercepted by the metaconglomerate. In these locations, Cambisols were dominant, but a small amount of Argisols could also be detected. In the eastern part of this region, Latosols were dominant (Fig. 8.4).

Archaeological and documentary information about the beginning of the period of occupation in this region are scarce. Information is also scarce concerning the exploration techniques that were adopted. Nevertheless, some hypotheses may be posed concerning the beginning of mining in this region. Regarding the beginning of mining, it is possible to consider that the discovery of gold was an outcome of expeditions that brought together the search for gold with the desire to fight the Kayapó do Sul, an indigenous group that occupied a vast area, extending from the southern part of Serra Dourada toward the south (Ataídes 1998). This possibility’s plausibility is strengthened if the experience of Baltazar Bueno is taken into account. Baltazar, who was considered to be a great expert of the Brazilian inlands, was

[5] Requerimento de Estevão Cabral de Távora, AHG, sesmarias, Cx.2, Pcte 9, n.9, 13.12.1754; requerimento de João de Macedo e Faro, AHG, sesmarias, Cx.1, Pcte 12, 19.11.1750; Requerimento de João Rodrigues Lobato, AHG, sesmarias, Cx.1, Pcte 6, n.5, 3.12.1752; Requerimento de José Alves da Cunha, AHG, sesmarias, Cx.1, Pcte 4, 12.10.1750; Requerimento de Manuel Vaz de Almeida, PEG, sesmarias, avulsos, Maço 10, n.478, 15.12.1750.

involved both in the fight against the Indians and the search for gold. He is known for discovering deposits not only at the foot of Serra Dourada but also in Anicuns, an area located further south that would only be explored in the early nineteenth century (Aguirra 1998; Bertran 1997b, p. 66; Moreyra 2015, p. 197).

The gold can be found in the alluvions associated with metaconglomerates from the Group of Serra Dourada, mentioned above, and quartzite and metaconglomerates from the Group of Old Goiás, in the Cantagalo Mountain range. These deposits are formed from the sediments that are transported and deposited by fluvial channels, and may contain other mineral resources. Since this kind of deposit is unconsolidated it may be easily explored, especially if it is compared with the veins that are found in rock formations. According to Souza and Reis (2006), colonial mining was usually carried out in alluvions and veins, and what made the largest difference in their exploration was the technique employed, which, in the latter case, was much more complex. This is particularly likely in the case of Goiás, where mining was carried out—especially in its initial phases—in the deposits existent in the alluvial water streams (Bertran 1991, pp. 42–43).[6] Two types of techniques were more frequently adopted in gold mining during the eighteenth century than others: gravel mining (carried out in secondary deposits related to alluvions) and hill mining (primary exploration related to rocks) (Guimarães 1996; Ribeiro and Leanza (2006)). Regarding hill mining, Ribeiro and Leanza (2006, p. 85) identified two related techniques. The most common methods for exploration of these deposits were the so-called opencast mining *(talho a céu aberto)*, which according to Ribeiro and Leanza (2006) was employed for the exploration of gold in friable rocks. This work was done with the help of water, used for dismantling the rock. Other techniques worthy of mention are the digging of wells, holes and galleries, which were used for the exploration of gold in the veins of quartz existent in rocks.

A documentary source dated from 1783 (Bertran 1997a, pp.116–118) reports that mining was practiced in four branches of the Fartura River (Figure 1.1). Gold found in this region was quickly depleted, which caused, on the one hand, the departure of some miners from that particular region, and on the other hand, the creation of rural units in the same location, giving birth to a small nucleus of food production.

Five *sesmarias*[7] were requested between 1750 and 1754, located in the exact spot where the gold was found. The individuals who made these requests were all part of

[6] According to Leinz and Leonardos (1977, p. 10) alluvion is a "generic designation that encompass recent deposits, of fluvial or lacustrine origin, constituted by gravels, sands, silts and clays from floodplains and the foot of mountains and cliffs." Gold usually is associated with gravels, which according to Wentworth (1922) constitute fragments of minerals and rocks with dimensions between 2 and 256 millimeters. From this definition, it can be noted that alluvions are conditioned to different characteristics related with rivers, as channels and flows. The intensity of erosive and depositional processes associated with the channel also influences the characteristics and distribution of alluvions. Changes in the layout of a channel, whether natural or anthropic, may modify the characteristics of deposits and thus the distribution of minerals as gold.

[7] Requerimento de Estevão Cabral de Távora, AHG, sesmarias, Cx.2, Pcte 9, n.9, 12.13.1754; Requerimento de João Alves da Cunha, AHG, sesmarias, Cx.1, Pcte 4, 12.3.1750; Requerimento

a privileged group in the local community, although they were not at the top of the social hierarchy of the period. Three of them were mid-ranked military officers, which was a socially respected position. This was the case with Ignácio Dias Paes, one of the discoverers of gold in the region, as well as João de Macedo Faro and João Alves da Cunha, who besides a miner and member of the military was the clerk of the casthouse of Vila Boa (Aguirra 1998, p. 11). The two others were liberal professionals: João Rodrigues Lobato, who appears in a document as the winning bidder of the renovation contract of the military quarters of Vila Boa (Bertran 1997b, pp. 59, 60); and Estevão Cabral de Távora, who possibly worked only as a miner. Estevão, who belonged to a family of nobles, married the daughter of a captain in São Paulo before emigrating to Goiás (Leme 1904, p. 386). All these individuals possibly got involved with mining at the local level, until the depletion of the gold deposits. As documentary sources reveal, their plantations possibly complemented the mining activity and served as a source of subsistence for their families and captives. In this sense, plantations created in this region had a dual goal, functioning as what was called "mixed farms," which were units that combined rural industry and gold mining (Godoy 2004).

The second region of expansion was also located in the southern part of Serra Dourada. This region, which predates 1755, followed the course of Urú River upstream. Its initial occupation was due to the of a large sugar-cane plantation called Engenho de Santo Izidro that, as time passed by, gradually expanded its limits and encompassed the locality known as Barreiro (Fig. 8.1). This plantation was abandoned in early nineteenth century and is presently the subject of intensive archaeological research (Souza 2015, 2016; Souza and Gardiman 2016). Its original owner, Francisco Xavier Leite de Távora, had ancestry linked to the Portuguese nobility. He was at the top of the social hierarchy of the community, being considered one of the most respected and feared of its members. The date of his arrival to Goiás is unknown. However, it is known that he was already living in Vila Boa in 1744, when he was appointed as *capitão-mór*, whose function was to work as the municipal military chief. It was possibly shortly after this date that he acquired the Engenho de Santo Izidro (Souza 2015).

This plantation was located in a relatively flat area, with the land predominantly made up of latosols (Fig. 8.4), and in the confluence of the river Urú, of fifth order, and Santo Izidro, of third order (Fig. 8.3). The sum of these characteristics made this place one of the most attractive for agricultural production in the area. Perhaps one of the most important attributes of this plantation was its drainage capacity, which is one of the highest in the region. Water availability may have been the predominant factor in the choice of this location, since the biome of the area –known as *cerrado*—has rivers and streams that may present a significant variation in their water flow between the summer (rainy period) and winter (dry season). In this sense,

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de João de Macedo e Faro, AHG, sesmarias, Cx.1, Pcte 12, 11.19.1750; Requerimento de João Roiz Lobato, AHG, sesmarias, Cx.1, Pcte 6, n.5, 10.12.1752; Requerimento de Manuel Vaz de Almeida, PEG, Avulsos, sesmarias, Maço 10, n.478, 12.15.1750; Requerimento de Estevão Cabral de Távora, AHG, sesmarias, Cx.2, Pcte 9, n.9, 13.12.1754.

this property could count on the availability of waters all year long. This higher availability must have also contributed to feeding a reservoir that existed in the property and served as an important water supply (Souza 2015).

This site bears no relation to the mountain chain Serra Dourada, since its water drainage flows in the opposite direction. It is strongly influenced instead by Serra das Lajes, a small ridge located further south (Fig. 8.3). As documentary sources suggest, mining did not take place in the Urú River, perhaps because of the absence of exploitable alluviums on its geological basement. Possibly because the owner of Engenho de Santo Izidro was unaware of the absence of gold deposits in the location of the site, he transported water to his property to aid in the process of prospecting for gold. In this site innumerable ramifications originating from the channeling of waters to the property were identified and at their end sparse concentrations of gravel, indicating prospecting activity (Souza 2015, pp.156–159).

The waters channeled for mining, agriculture or both may have altered the existing river channels, especially the intensity of their flow, thereby interfering with the transportation of water, the deposition of sediments and, consequently, the deposition of gold. Processes such as the decrease of water flow due to water diversions could affect the deposition of graves. The water flow could change its position in the fluvial channel or become more restricted to the channel springs. The interaction between human activity and the functioning of these rivers was possibly quite intense in the region considered here during this early settlement period, resulting in new configurations. In this sense, it may be useful to conduct further investigations concerning the water captation systems that are directly connected to auriferous watercourses. Such studies will most likely also be capable of detecting changes in these various channels of water.

As we noted before, the territory of Kayapó Indians was invaded so that mining areas and plantations could be founded. The Kayapó occupied a vast area of Central Brazil during this period, as can be seen in Fig. 8.5. For this reason, a number of expeditions devoted to the destruction of Indian villages and the capture of prisoners took place during this period. As a reaction, the Kayapó offered relentless resistance to the invasive presence of the colonizers throughout the eighteenth century. They attacked roads, plantations and colonial villages, including the surroundings of Vila Boa and Ouro Fino, as well as the vicinities that would later become part of Mossâmedes (Ataídes 2001, pp. 75–88; Chaim 1983, p. 62). For this reason, patrolling incursions financed by the settlers and miners were frequent (Ataídes 2001, pp. 75–76). Relations between the Kayapó and the colonizers in this region were always tense and volatile except for a period between 1755 and 1777, when the Portuguese Crown stimulated pacification through religious practices, which seems to have contributed toward the successful conquest of this territory (Chaim 1983, pp. 67–102). As these conflicts developed, it is worth to note that these indigenous groups were major participants in the process of entanglement between humans and the environment at that period.

In order to make progress in the fight against the Kayapó, besides the colonial initiative mentioned above, two strategies were employed by the owners of lands in this region. The first involved human capital. Some of the land owners who possessed

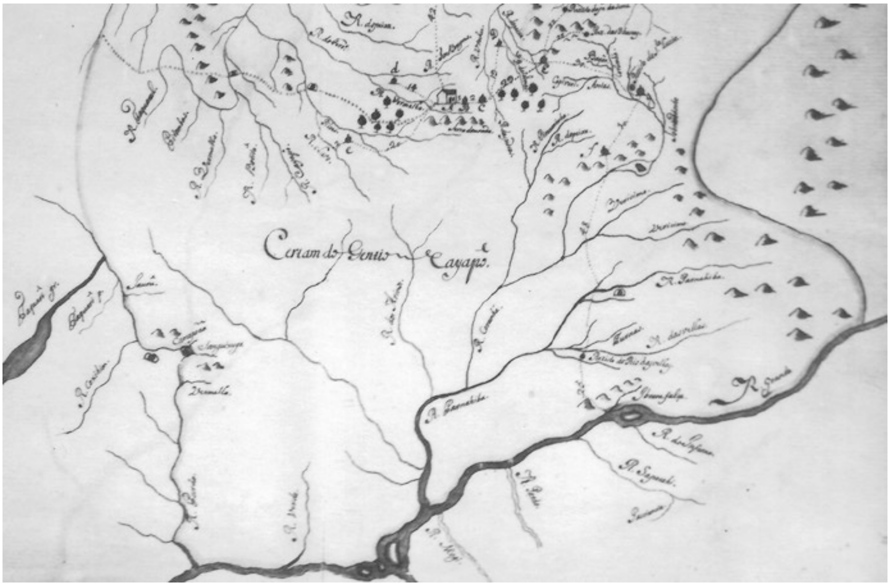

Fig. 8.5 Untitled map, Angelo dos Santos Cardoso, 1753 (partial reproduction). (Note in the selected area the villages of Vila Boa (A), Ferreiro (B) and Ouro Fino (C), as well as the Serra Dourada. In the south, the unconquered area is known by the colonizers to be "*Sertão do Gentio Cayapo*" (gentile Cayapo interland))

portions of land in close proximity to the Kayapó territory were accustomed to confronting the Indians. This was the case of Baltazar Bueno and Ignácio Paes, who had participated in the initial expedition to Goiás, and consequently, had prior experience with the Brazilian inlands and their native inhabitants. Others, such as Francisco de Távora, who owned the Engenho de Santo Izidro, were rich and powerful owners, and therefore had the necessary means to face an armed conflict. As we noted before, Távora was the military chief of Vila Boa. In addition, he had more than 150 enslaved individuals living on his property (Souza 2016, p. 148) and thus had the support of a group of men large enough to face an indigenous attack, because the number of Kayapó engaged in such struggles rarely surpassed this number.

A second strategy involved fostering interactions with elements of the environment in order to establish physical frontiers. This was the case of the pioneer plantations established in areas that later on would become a part of Mossâmedes and whose boundaries were protected on the one hand, by Serra Dourada and, on the other, by the Fartura River. Without any exception, all land requirements from this period stipulated the right margin of Fartura River as the property limit. Fartura River begins in Serra de Santa Marta and extends to the west (Fig. 8.1). This river has an index of sinuosity that exceeds 1.5, which makes it compatible with meandering channels, even though some rectilinear segments are distributed along its course. Images available in Google Earth (access in 10.1.2017) indicate that its alluvial plain is predominantly narrow. In such situations, the channel has a reduced area for changing its path, and is limited by its margins, which can bring about the erosion of previous deposits. In these cases, concave and convex margins can be observed. The convex margins are caused by depositional processes and low slopes, which tend to favor access to the channel. The concave margins, on the other hand, may be the result of erosive processes in the channel that tend to form a segment with a high slope. All these distinctive features maximized this river's ability to serve both as a landmark and a frontier.

8.2.3 From 1756 to 1765

After 1756, a higher number of land portions were requested by the Portuguese Crown. During this period, they radiated in three different directions. The first area of expansion originated from the Royal Road and the plantations existing in that location. By 1765 the properties reached the northeast portion of Serra das Lajes (Fig. 8.1). These properties certainly benefited from their proximity to the Royal Road, which was the major road in the area. There is little information available about their owners and it is possible that these were individuals with fewer possessions, when compared with previous owners. This assumption is supported by what is known about the creation of the village of Curralinho (later Itaberaí) in circa 1775. According to historical research, this community was founded by poor farmers living in the region (Pinheiro 2003).

A second zone of expansion followed the Urú River upstream, where better lands for rural activity were located. The occupation of this particular area began with the creation of a large cattle-raising farm: the Sobradinho, which was archeologically identified (Fig. 8.1). As in the case of Engenho de Santo Izidro, it belonged to one of the most affluent members of the community, Antônio Gomes de Oliveira, who arrived in Goiás in 1740 and soon built a small fortune through the production of beef and cattle by-products. He was the owner of a butcher's shop in Vila Boa and became the only tanner of the village, establishing a profitable monopoly in the trading of calf leather. (Lemke 2011, 2013, p. 1).

Later on, this expansion would extend to more southerly locations, and get closer to the sources of the Urú River. This locality would arouse the interest of two new individuals, who, just like Távora and Oliveira, were persons of high rank socially. The first was Manuel da Silva, who was born in Rio de Janeiro and was a Doctor in medicine trained at the University of Coimbra, Portugal (Leme 1904, p. 497). He later became the administrator of the Royal Military Hospital of Goiás, located in Vila Boa (Age 2014, p. 92). When the governor Dom Marcos de Noronha took office in 1749, Manuel da Silva's name was on the guest list (Alencastre 1864, p. 94), which serves as an indicator of his high status. The other was João Alves Vieira. A rich miner, his name could be found on a list sent to Portugal in 1752 with more than 300 names of men who paid their taxes in gold within that province.[8]

[8] "Mapa da capitação com a lista nominal de manifestantes de VB em 1752," AHU, São Paulo,

Notably, his name was in fourth place on the list. Later on, along with Távora, he would become involved in a scandalous corruption scheme that entailed embezzlements from the province entry contracts. For this, he was required to return part of the stolen money to the royal treasury when he was sentenced (Alencastre 1864, pp. 152–153).[9]

It is interesting to note that these three new properties were established as cattle farms. Rare in the southern part of Serra Dourada, they clearly tended to concentrate in this region, thereby constituting a zone of specialized production. As the owner of Sobradinho had a butcher's shop as well as a monopoly on the leather trade, it is possible that his property served as a center for local production.

In the establishment of these cattle farms, it seems that their owners followed two general rules mentioned by Antonil in the book he published in 1711 about Brazilian productive activities. According to him, Brazilian cattle corrals tended to be located in large and open fields, where there existed a stable supply of water, originating from rivers and lagoons (Antonil 1923, p. 262). Consistent with this, it can be noted that these farms were located where there was a predominance of flat terrains with reasonable agricultural capability. It also may be noted that this region had many accessible rivers, each one of which had a reasonable amount of water flow (Fig. 8.3). It is also noteworthy that these farms covered very wide areas. For instance, the piece of land required by João Vieira was the size of 3 x 3 *léguas,*[10] which contrasts to the size of most of the lands in the southern part of Serra Dourada, measured from ½ × ½ to 3 × 1 *léguas*. In this sense, these measurements seem to match with what Antonil observed in other Brazilian contexts.

The surroundings of the initial area of occupation located at the foot of Serra Dourada would constitute a third zone of expansion during this period. In this region, a number of new portions of land would also be allotted by the Portuguese Crown to the settlers. Some of the settlers occupied the interstices of the existing ones. Others expanded in order to occupy the entire right margin of Fartura River. Two plantations found in the region possibly date from this period: Engenho da Conceição and Gorgulho (Fig. 8.1).

This segment possesses a vast system of drainage, given the fact that the Fartura River functions as a major canal. The majority of the watercourses in this region have springs in Serra Dourada and drain in the Fartura, whose springs are not connected to Serra Dourada. Some other rivers and creeks are not linked to Serra Dourada. For instance, this is the case of the river that crosses the place where Mossâmedes was later founded. Some of its tributaries have their springs in the lowered plateau, especially those that according the classification of Strahler (1957) are of first and second orders (Fig. 8.3).

documentos avulsos, CU.023, Cx.4, Doc.257.

[9] See also the extensive documentation for this case in AHU.

[10] Légua = Ancient portuguese measure equivalent to ca. 5.6 kilometers; Pedido de confirmação de sesmaria de Domingos Martins Pinto, AHU, IPEHBC, Cx.18, Doc.1051, 10.28.1764.

Evidence shows that this region was occupied by less affluent individuals. None of the solicitants found[11] in these records were part of the military or administrative bodies of the province—both of which serve as an important indicator of social status. It is very possible that these particular solicitants were mainly miners and farmers of lower status.

If the process of expansion that occurred in this period is considered as a whole, it becomes clear that a difference existed between two types of owners. The first was integrated by those who requested lands along the *Estrada real* and the Fartura River and who were part of the lower and medium segments of the regional elite. The second was made up of those who occupied the region along the Urú River, and who were considered to be part of the top of the social hierarchy in that period.

At this point, it is important to note that these differences are related to intrinsic qualities that can be identified within the environment itself, since the Urú River—the segment occupied by the richest segment of the population—had favorable environmental conditions, especially if one takes into account the common understanding about agriculture and farming during that period. The variation according to social class may be observed in the layout of the terrain. Its altimetry was greater in Engenho de Santo izidro and Sobradinho, when compared to the Fartura River. Regarding the topography, the terrain layout ranges from plain to smoothly undulated (Fig. 8.3). This feature allowed for roads free of interferences, favoring the circulation of people, domesticated animals and products. It would also allow for easier transportation of water to the places where the machineries used in the processing of goods were located. Conversely, the area in the Fartura River was more undulated with dissected hills, which could make human action more difficult.

Another important difference has to do with the types of soil associated with these different compartments. In the Urú River, latosols predominate, especially in the locality occupied by Engenho de Santo Izidro, whereas in the Fartura River there are only cambisols (Fig. 8.4). Although the fertility of these different types of soils varies (Reatto et al. 1998), the nature of the soil appears to be related to the characteristics that are perceived to be present in different types of environment, according to those who relate directly to these environments through agricultural practices. In writing about the best soils for sugar-cane farming, Antonil (1923) mentioned that the best type was *massapê*. This soil type is characterized by a dark, almost black color, high fertility and high clay content, and tends to be found especially in the Brazilian northeastern coast. In the area considered here, this soil type may possibly be vertisols or argils, which apparently originate from basic and ultrabasic rocks. Its relation with hydromorphic soils and gleysols, which are found in locations that are poorly drained (Reatto et al. 1998, p. 80) and subject to flooding especially near the watercourses, cannot be discounted. The second-best type of soil

[11] Requerimento de Antônio Carneiro da Silva, AHU, IPEHBC, Cx.23, Doc.1421, 8.1.1761; Requerimento de Antônio da Costa Pereira, AHG, sesmarias, Cx.4, Pcte 27, n.1, 7.29.1765; Requerimento de Antônio Ferreira da Costa, PEG, sesmarias, avulsos, Maço 1, n.56, 4.6.1763; Requerimento de João Taveira de Souza, PEG, sesmarias, avulsos, Maço 1, n.76, 11.11.1762; Requerimento de Francisco Ferreira Velho, AHU, IPEHBC, Cx,22, Doc.1345, 4.9.1766[1762].

for cane farming, according to Antonil, was the red soil (*Terra Vermelha*), which may be connected to latosols, widely used in Goiás for sugar-cane plantations and highly present in Engenho de Santo Izidro, as well as other properties along the Urú River. If these assumptions are correct, it is possible that the presence of latosols also elevates the value of this locality in the region as a whole.

Finally, a last difference can be attributed to the drainage network. Both the Urú and Fartura rivers had a dense network and, therefore, are suitable for agricultural activity. However, differences may be observed in their forms of drainage. As can be seen in Fig. 8.3, the drainage in the Fartura River region is dendritic. In the Urú River region, the pattern is not well defined, showing a tendency for rectangular and dendritic segments. The problem of water transportation in the region of the Fartura River, where sinuous watercourses and an undulated terrain prevailed, could be overcome through the adoption of specific techniques for the construction of channels in elevated areas, taking advantage of the pull of gravity, which was a solution commonly adopted in other eighteenth century mining areas of Central Brazil (e.g., Madureira 2005). Nevertheless, we acknowledge that owners who established their plantations along the Urú River possibly perceived that in this region the transportation of water would require less complex techniques, which could also make it more valued.

It must also be observed that the larger properties tended to be strategically placed in close proximity to the rivers or crossed by them, which assured a regular flow of water throughout the year. This proximity was especially important since, as mentioned before, in the Cerrado biome the winter is dry and can possibly affect the flow of waters. This difference was demonstrated in a study carried out by Vieira et al. (2014) in the area. They established a correlation between precipitation and the height of the Red River in the vicinity of the City of Goiás (formerly Vila Boa) between 1996 and 2001. In their study the lower quota was of 45 centimeters and the precipitation of zero millimeters, while the higher was of 180 centimeters and the precipitation of 550 millimeters. These data illustrate how variation in the rate of the water flow may be significant in the area. In this sense, properties placed close to these water streams would require less adjustments in construction efforts so as to ensure water availability during the dry winter.

The two watercourses of greater volume that exist in the southern part of Serra Dourada—the Fartura and Urú rivers—helped to guide the process of colonial occupation in the period between 1746 and 1765. So did the roads. Roads helped expansion by connecting different participants to the landscape. During this period several new roads were created, branching out from the Royal Road and the existing villages, as different maps dated from this period indicate (Fig. 8.1).[12] In addition, bridges were constructed. When the rivers were not being used for other purposes, crossing of rivers was carried out by the so-called "*paris*" (fords). One of them—the *Pari do Fartura*—was mentioned in one document[13] as being used for the

[12] "Carta topográfica do pais dos rios Claro e Pilões," Thomás de Souza, 1772; "Mapa de Vila Boa de Goiás e tudo o mais que pertence a seu termo," unknown author, 1758.

[13] Requerimento de José Alves da Cunha, AHG, sesmarias, Cx.1, Pcte 4, 12.10.1750.

transposition of the Fartura River, which, according to the same source, was located in the place mentioned in Fig. 8.1. This ford was placed in this particular way possibly because, as a result of geomorphological processes, it lent itself to fording. Fords are rarely just a matter of human choice (Edgeworth 2011, pp. 107–127) and its capacity for allowing the crossing of the river may have been influential. In the case of the one in the Fartura River, the concave margins would certainly facilitate the process of crossing the river. With the expansion of the colonial frontier, the transposition of the Fartura River at this point began to be done in a more systematic way. Possibly because it functions efficiently, this point is nowadays the crossing place of a modern road.

8.3 The Creation of *Quilombos*

In the area here considered, there were a number of settlements occupied by runaway slaves—known in Brazil as *Quilombos*. Although archaeological sites associated with this type of occupation have not yet been found, different lines of evidence suggest their existence. One of the major forms of evidence is a series of indicative toponyms that have been mentioned at least since the mid-nineteenth century.[14] These toponyms include terms such as "*Quilombo*," "*Quilombo River*" and "*Quilombo Mountains*," as well as others whose etymology are indicative of an African-descendent presence, such as "*Congomê*" and "*Manuel Congo*." Added to this evidence is the existence, in the same region, of a community that during the twentieth century was considered a remnant of *Quilombos* and was known as "blacks from the mountains" (*Pretos da Serra*; A.C.C. Pinheiro, personal communication, July 7, 2016). A site dated from the first half of nineteenth century that was located not far from this region and that was studied by Nóbrega (2014) corroborates this assumption. According to Nóbrega, evidence found in this site suggests that a "bush community" ("*comunidade do mato*") existed there, which, according to Agostini (2002), refers to African-descendent communities, composed of either runaway slaves or emancipated persons, which lived "in between worlds," occupying liminal spaces within society during the past.

All evidence related to runaway slaves in the region suggests that they were concentrated in the southeastern part of the area of expansion (Fig. 8.1). Located between the zones of colonial expansion and the Kayapó territory, this occupation consisted in a range of different associations, involving people and the elements existent in the surrounding environment. Such associations represented strategies aimed at confronting the risks that the people were exposed to within this particular place.

In this region, a type of vegetal covering known as *mato grosso de Goiás* is particularly dominant, which is deeply related to the formation of forests in the *Cerrado* biome. This vegetation is formed by large trees, with an overarching cover that

[14] These toponyms are mentioned in the survey of land owners from the province of Curralinho, Goiás, carried out between 1856 and 1857 (Registros Paroquais de Terras, Curralinho, IPEHBC).

oscillates between 50% and 90% in width and an arboreal stratum varying from 8 to 15 meters in height (Ribeiro and Walter 2008). If compared with most, it certainly offered better conditions for runaway slaves to hide in moments of extreme danger.

The relief of the terrain in this region was also distinct from its surroundings. Its altimetry had a more marked variation in the higher points of the terrain when compared with the regions we described above. The region where it is located results from a planation process which creates a surface with medium dissection, with heights varying between 700 and 800 meters and with the presence of some mounds and hills (Latrubesse and Carvalho 2006). Although this process provokes a medium dissection, it favored the creation of deep valleys, characterized by steep slopes and shallow soils that are intercalated with flatter areas (Fig. 8.3). The association between more elevated altimetry and the existence of higher quotes, with the formation of mounts and hills, allowed for a better visual control of the space. It could also make the identification of settlements more difficult, as well as the movement of individuals not fully familiarized with this environment. These features offer an adequate place for shelter that allowed for a highly vigilant stance in the face of any imminent dangers.

Corroborating evidence can be added to this data. In this region soil is predominantly composed of Argisols (*Argissolos*), which is characterized by a variable fertility, depending on the basement rocks (Reatto et al. 1998). In addition, basement rocks do not present any potential when it comes to gold exploration. Both factors reduced the economic potential of the region. Consequently, it did not attract colonizers in this particular period.

Despite these predominant characteristics, in some areas, there are stretches of flat terrain which might have made this region fairly easily accessible to possible settlers. There were also Latosols (*Latossolos*) and Cambisols (*Cambissolos*) soil types, both with variable fertility, which are reasonably suitable for agricultural activity. These factors mentioned above (flat terrain and soils), were most often found to exist in sheltered places, surrounded by hills and, thus, protected from the colonizers. This could be the case of the place located near the Quilombo River (Fig. 8.1), in a lowland with more fertile soils and flat terrain, as well as being protected by hills (Figs. 8.3 and 8.4). These places in particular could constitute an important resource for agricultural activity, used for subsistence or trade purposes, and developed on the margins of the colonial economy.

As we already pointed out, the runaway slaves' settlements were located between the colonial and indigenous territories. The kind of interaction that took place between these different groups is at this point uncertain. Information from archaeological investigations carried out in sites located nearby the runaway slaves' settlements may illuminate this problem.

Despite the limitations in the analysis to be made due to lack of data, it is important to highlight the significance of the location occupied by the runaway slaves in the region considered here. The environmental compartment that they occupied had particular qualities and capacities related to different types of vegetation, altimetry, relief of the terrain and types of soil. As has been argued here, through interactions with these elements, the landscape in this region became suitable for the survival of communities of African descent. There is no documentary evidence that mentions the existence of these settlements or of possible efforts to eradicate them. This silence serves as evidence that these settlements were successful. Their capacity to survive may also be evident if we take a closer look at the trajectory of this community through time. As we mentioned earlier, in the twentieth century there was an African-descendent community in this region, which suggests that the experience of this particular social group found a way to be sustained through time. Although located in a dangerous frontier, this community seems to have found the means for its perpetuation.

8.4 The Constitution of Entanglements

The constitution of this area during the colonial expansion period was the product of a series of interactions involving people and things. Interactions involving human beings were the product of different interests, motivations, and goals, certainly based on technical and empirical knowledge that was acquired and adapted. When it comes to things, we perceive that these interactions were related to their intrinsic qualities, which had real and objective properties. In several instances, things have exercised many of their capabilities, including those listed by Latour (2005, p. 72), such as authorize, allow, afford, encourage, permit, suggest, influence, block, render possible and forbid.

The interactions that took place in this particular area helped to fortify bonds between its different actors. Each episode that involved human-based interactions was unique due to the participation of different groups, each of which was briefly mentioned in this chapter: mountains, hills, slopes, plains, obstacles, paths, roads, rocks, types of soil and vegetation, bodies of water, reservoirs, minerals, and so on. Their existence affected the formation of associative networks.

In each moment of this period of colonial expansion in the area, new networks were created. In its initial moments, the human presence was associated with the Red River, in whose fluvial channels gold had been previously deposited. Villages were founded, along with mining zones. As we showed in this text, a series of associations connected with gold, including the formation of its deposits, its level of incidence and forms of transportation were connected to others, concerning human intentions and associated with specific kinds of technical and empirical knowledge. These associative networks, complex in nature, were crucial in the beginning stages of the colonization of the area.

Some regions where gold was explored eventually acquired new functions, such as those regions situated in the foot of the mountain Serra Dourada, where deposits were quickly depleted. In this location, colonial activity shifted to mixed exploration, involving different elements, and then transitioned to a specialized one, solely focused on agriculture. These changes point to an important quality of these networks: their instability. As Callon (1986, pp. 219–221), points out, they are subjected to "betrayals and controversies." Since they are composed by heterogeneous, dynamic and sometimes finite entities, they are always subject to rearrangements. Processes such as the depletion of mineral deposits in the research area affected the organization of networks, producing new configurations, sometimes in quite short periods of time.

In order to guarantee a constant food supply for the villages, the region located in the southern part of Serra Dourada became specialized in the production of food. Its productive capacity was established through alliances that involved different types of materiality. Perhaps the most evident example of this would be the system of roads, which functioned as conduits. Along with roads, came other types of materiality, such as bridges and fords, which also have the ability to bring together different portions of land, connecting fields, villages and so forth. Borrowing an expression used by Edgeworth (2011, pp. 121–122), we might consider these materialities to be *gatherings*.

As the landscape during the colonial period went through new stages of development, new alliances between people and things were created. Some of them were related to specific activities. As we noted before, some zones of productive activity were established, including properties of mixed agriculture activity and cattle farms, each one associated with specific attributes of the surrounding environment.

Other types of alliances were related to power relations. The process of colonial occupation along the Fartura and Urú rivers most definitely illuminates these power dynamics. The entreaty for portions of land during the eighteenth century in central Brazil was made by the wealthier members of society. Only the more privileged classes possessed both the resources and human capital necessary for the maintenance of these properties. It is known that the vast majority of the people who lived in the colonial mining areas in Brazil were poor (Souza 1990). Therefore, only a small group of individuals could afford pieces of land, and it was the members of this group who actually requested lands from the Crown. However, there were differences within this group. As we demonstrated in this chapter, the individuals who belonged to the upper level of the local elites were associated with environmental elements that allowed for maximizing food production and facilitated the transit of people, animals and goods, all of which were located along the Urú River. Conversely, those who occupied the lower and medium levels of the local elite's hierarchical structure were associated with elements existent along the Fartura River and with qualities that were not comparable with those that were found by the Urú River. In this discussion, it is useful to consider that the *sesmarias* were donations from the Crown and thus had no costs beyond the costs of using and controlling the granted land. Hence, these different associations were involved with tacit negotiations that certainly were based on the power inequalities that existed in the society at that time.

Further south, new alliances would also be formed, most of them involving runaway slaves. These individuals engaged in associations with distinct characteristics. They lived in a region that was difficult to access, with closed forest vegetation, rough terrain and poor soils and therefore had no appeal to the colonizers. These particular elements ensured their survival. They also allowed for the creation of new ethnic identities. It is our belief that the constitution of this new landscape, as well as the emergence of new alterities, happened as the result of successive processes of translation, in the terms articulated by Callon (1986). As noted by him (1986, p. 223), translation involves displacement and transformation. Looking at this from a human perspective, we come to understand that this process happens because as claims pass through different mediums they are transformed. According to Callon (1986, pp. 222–223) the translation processes can be defined as “to express in one’s own language what others say and want, why they act the way they do and how they associate with each other: it is to establish oneself as a spokesman.” We believe that this was pretty much what happened in the region occupied by the runaway slaves. Through the process of translation that took place in the region, it was possible to observe the spatial reconfiguration of alterities that are crucial components of the original model defined by the colonial society. As these alterities were established, they tended to obtain some stability. As we pointed out, at least part of this community kept its identity as African-descendent people in the periods that followed the colonial era. This kind of inertia—which is considered by the theorists of ANT as exceptional (Latour 1996)—represented a form of resistance to slavery and the subsequent developments.

The constitution of the landscape in the area considered here cannot be seen as a phenomenon separate from the arrival of different groups of individuals, who joined together in distinct types of associations. These arrivals had as a consequence the displacement (at least in partial terms) of the Kayapó people. The tensions that arose as a result of the colonial invasions were at a certain point inscribed in the landscape, being expressed through the creation of physical frontiers that contained rivers and mountains. However, the perception that indigenous groups themselves had is uncertain, and at this point it is necessary to consider that the indigenous groups were already engaged in person-thing entanglements before the arrival of colonizers, as were in the process of colonization. They were active players before and during this process. Future investigations of sites occupied by the Kayapó in this period may add new and indispensable elements to our understanding of this matter.

In the following periods, the colonial frontier would gradually expand, and in this process, indigenous groups would be tentatively incorporated into the colonial landscape. Official settlements were created with the intention of gathering these groups together in order to pacify them. To reach this goal, the Portuguese Crown founded two villages: Mossâmedes (1774), which eventually became a town, and Aldeia Maria (1781), established further south and abandoned 32 years after its foundation (Chaim 1983). New settlers’ villages were also created. This was the case of Curralinho (ca.1775), which was founded by local farmers, and Anicuns, a mining settlement created in the early nineteenth century and located in the southern part of Mossâmedes. In the vicinities of these villages new rural units were created. In the beginning of the nineteenth century, the colonial frontier would continue expanding southward and would penetrate more deeply into the Kayapó territory.

8.5 Concluding Remarks

By way of conclusion, we would like to stress two points that we believe to be of particular interest to Historical Archaeology. The first involves a paradox that certainly demands attention. As we hope to have demonstrated in this chapter, human presence in the pioneer area of colonial occupation in central Brazil—and especially in the southern part of Serra Dourada—was intertwined with the environmental components of the landscape; and this proven fact bring us to an issue that has a much broader scope. In the emergence of the modern world things happened exactly the opposite of what we have obsessively tried to demonstrate in our studies about the "social landscape": the more the social dimensions seemed to have primacy over the natural aspects, creating a sense of distance from nature itself, the more they became entangled in the natural world. This paradox has long been noted by Latour (1993) in his brilliant study about the modern condition. The case we examined in this chapter refers to the first encounters between different subjects, materialities and agents. Bearing in mind these considerations, it is our understanding that the examination of situations of this kind may contribute to our understanding of the conditions that have shaped the modern world—in which culture, society and nature were inextricably related—and how these dimensions have unfolded through time.

A second point concerns the ways in which these processes occurred. In Brazil, colonial society had a highly hierarchical organization, defined by Faoro (2000/1958) as having an *estamental* basis (*stand* in German). Ethnicity and power, here examined, are only a few of the categories related to this form of social organization. Types of organization like this—and they were far from being exceptional—required that associations among people, things and ideas be developed with intensity and with a high level of complexity. In our understanding, this form of organization usually had as a result an overwhelming set of associations. The creation of hierarchical networks, the high level of environmental components, the dispersion of indigenous populations and the creation of new ethnicities are just some of the many implications of these forms of organization. These new forms were being created during the formation of the modern world and certainly deserve our attention.

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References

Age, M. D. P. P. D. S. (2014). *O hospital real militar: saúde e enfermidade em Villa Boa de Goyaz (1746–1827)*. Goiânia: Universidade Federal de Goiás.

Agostini, C. (2002). Entre senzalas e quilombos: "Comunidades do mato" em Vassouras do oitocentos. In A. Zarankin & M. X. Senatore (Eds.), *Arqueologia da sociedade moderna na América do sul* (pp. 19–30). Buenos Aires: Editora del Tridente.

Aguirra, J. B. D. C. (1998). *Parentes Provisões e Sesmarias concedidas pelos governadores da capitania de São Paulo, Referentes ao atual estado de Goiás em 1726 a 1742*. Goiânia: Arquivo Histórico de Goiás.

Alves Vieira, P., Ferreira, N. C., & Guimarães Ferreira, L. (2014). Análise da vulnerabilidade natural da paisagem em relação aos diferentes níveis de ocupação da bacia hidrográfica do rio Vermelho, estado de Goiás. *Sociedade & Natureza, 26*(2), 385–400.

Antonil, A. J. (1923). *Cultura e opulência do Brazil por suas drogas e minas*. São Paulo: Melhoramentos.

Bertran, P. (1991). Desastres ambientais na capitania de Goiás. *Ciência Hoje, 12*(70), 40–48.

Bertran, P. (1997a). *Notícia geral da capitania de Goiás em 1783* (Vol. 1). Brasília: Solo Editores.

Bertran, P. (1997b). *Notícia geral da capitania de Goiás em 1783* (Vol. 2). Brasília: Solo Editores.

Callon, M. (1986). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In J. Law (Ed.), *Power, action and belief: A new sociology of knowledge?* (pp. 196–223). London: Routledge.

Chaim, M. M. (1983). *Aldeamentos indígenas (Goiás, 1749–1811)*. São Paulo: Nobel.

da Silva Leme, L. G. (1904). *Genealogia paulistana* (Vol. 2). São Paulo: Duprat & Comp.

da Silva, O. P. (1995). A mineração em Minas gerais: Passado, Presente e Futuro. *Geonomos, 3*(1), 77–86.

de Alencastre, J. M. P. (1864). Annaes da provincia de Goyaz. *Revista do IHGB, 27*(2), 5–186.

de Ataídes, J. M. (1998). *Sob o signo da violência : colonizadores e Kayapó do Sul no Brasil central* (Vol. 4). Editôra da UCG: Goiânia.

de Ataídes, J. M. (2001). *Documenta indígena do Brasil Central*. Goiânia: Editora da UCG.

de Souza, M. A. T. (2015). O século 18 em Goiás e a visão de mundo barroca: dois estudos de caso. *História Revista, 20*(2), 140–174.

de Souza, M. A. T. (2016). Behind closed doors: Space, experience, and materiality in the inner areas of Brazilian slave houses. *Journal of African Diaspora Archaeology and Heritage, 5*(2), 147–173.

de Souza, M. A. T., & Gardiman, G. G. (2016). A alimentação em dois engenhos brasileiros nos séculos 18 e 19: Circulação, sujeitos e materialidades. In F. C. Soares (Ed.), *Comida, cultura e sociedade: arqueologia da alimentação no Mundo Moderno*, *Estudos Contemporâneos na Arqueologia* (pp. 65–94). Recife: UFPE.

Edgeworth, M. (2011). *Fluid pasts*. London: Bristol Classical Press.

Faoro, R. (2000/1958). *Os donos do poder* (10a ed.). São Paulo: Editora Globo.

Godoy, M. M. (2004). Fazendas diversificadas, escravos polivalentes: Caracterização sócio-demográfica e ocupacional dos trabalhadores cativos em unidades produtivas com atividades agroaçucareiras de Minas Gerais no século XIX. In *XVI encontro nacional de estudos populacionais*. Caxambu: ABEP.

Guimarães, C. M. (1996). Mineração colonial e arqueologia: potencialidades. *Revista de Arqueologia, 9*, 55–64.

Latour, B. (1993). *We have never been modern*. Cambridge, MA: Harvard University Press.

Latour, B. (1996). On actor-network theory. A few clarifications plus more than a few complications. *Soziale Welt, 47*, 369–381.

Latour, B. (1999). *Pandora's hope: Essays on the reality of science studies*. Cambridge, MA: Harvard University Press.

Latour, B. (2005). *Reassembling the social*. Oxford: Oxford University Press.

Latrubesse, E. M., & de Carvalho, T. M. (2006). *Geomorfologia do Estado de Goiás e Distrito Federal*. Goiânia: Secretaria de Indústria e Comércio/Superintendência de Geologia e Mineração.

Leinz, V., & Leonardos, O. H. (1977). *Glossário geológico*. São Paulo: Editora Nacional.

Lemke, M. (2011). Os Mina na pia de batismo da Catedral de Sant'Anna: Goiás no tráfico atlântico, 1762–1820. In *5o encontro escravidão e liberdade no Brasil meridional*. Porto Alegre: Universidade Federal do Rio Grande do Sul.

Lemke, M. (2013). Entre a Casa Grande e a senzala: a pia batismal. Notas sobre relações familiares em Goiás, 1764–1850. In *6o encontro escravidão e liberdade no Brasil meridional*. Florianópolis: Universidade Federal de Santa Catarina.

Madureira, P. J. (2005). *O ciclo da mineração no município de Luziânia—Goiás: o rego do Saia Velha e as alterações na paisagem*. Goiâ: Pontificia Universidade Católica de Goiás.
Moreyra, S. P. (2015). *Vida sertaneja, aspirações metropolitanas: alunos da Universidade de Coimbra nascidos em Goiás*. Goiânia: Editora da UFG.
Nóbrega, V. M. D. M. (2014). *O barro na mão do oleiro: ressignificações e sensibilidade através da cultura material*. Goiânia: Pontifícia Universidade Católica de Goiás.
Pinheiro, A. C. C. (2003). *Os tempos míticos das cidades goianas: mitos de origem e invenção de tradições*. Goiânia: Universidade Federal de Goiás.
Reatto, A., Correia, J. R., & Spera, S. T. (1998). Solos do bioma Cerrado: Aspectos pedológicos. In S. M. Sano & S. P. de Almeida (Eds.), *Cerrado: ambiente e flora* (pp. 47–86). Brasília: Embrapa.
Ribeiro, L., Leanza, D. (2006). O complexo arqueológico do córrego Cuiabá e o mito das tecnologias da mineração nas Gerais colonial. *Revista de Arqueologia*, 19, 65–87.
Ribeiro, J. F., & Walter, B. M. T. (2008). As principais fitofisionomias do Bioma Cerrado. In S. M. Sano & S. P. de Almeida (Eds.), *Cerrado: ecologia e flora* (pp. 153–198). Brasilia: Embrapa.
Rockman, M. (2003). Knowledge and learning in the archaeology of colonization. In M. Rockman & J. Steele (Eds.), *Colonization of unfamiliar landscapes: The archaeology of adaptation* (pp. 3–24). London: Routledge.
Salgado, G., de Azevedo, C. L., Pêcego, E., Vianna, P. F., Hippolito, R., & Barrreto, Z. M. (1985). *Fiscais e meirinhos : a administração no Brasil Colonial*. Rio de Janeiro: Editora Nova Fronteira.
Singer, P. (1977). *Desenvolvimento econômico e evolução urbana*. São Paulo: Companhia Editora Nacional.
Souza, L. d. M. e. (1990). *Desclassificados do ouro: a pobreza mineira do século XVIII*. Graal: Rio de Janeiro.
Strahler, A. (1957). Quantitative analysis of watershed geomorphology. *American Geophysical Union Transactions, 38*, 913–920.
Wentworth, C. K. (1922). A scale of grade and class terms for clastic sediments. *Journal of Geology, 30*, 377–392.

Chapter 9
The Deep History of the *Ficus thonningii Bl.* in Central Africa: Ontology, Settlement, and Environment among Lower Congo Peoples (Early Times to ca. 500 B.C.E.)

Marcos Leitão de Almeida

Abstract Recent studies on the relationship between human migration and environment in ancient Central Africa have made important advances in understanding the relational development among Bantu-speaking settlers, fruit trees and expanding savanna-corridors due to climate-induced destruction of the Central African rainforest during the last millennia B.C.E. However, the persistent lack of a broader set of reconstructed vocabularies about human–environment relations prevented scholars from incorporating in their explanations the ways in which people in the past *perceived* their own surroundings as they moved to new lands. Using historical linguistics, cognitive linguistics and comparative ethnography, this chapter discusses how the *Ficus thonningii Bl.*, a native species of Central Africa, was used in the ritual for the foundation of new villages to establishing the condition for engagement between newcomers and terrestrial spirits of newfound lands. Moving beyond modernist assumptions about the separation between human and nature and mind and body, it shows how a host of embodied practices and cognitive processes marked the tree as a central entity in local ideologies. Focusing on how Lower Congo peoples *engaged* with the tree in the first millennia B.C.E., such an approach offers new insights into the relation between ontology and environment in an important region of Central Africa.

> Nzambi Mpungu Uyidika Beto Min'ti Dimoya 'God set us in order as living trees' Kongo Proverb (MacGaffey 1986, 127)

> By recognizing the **central role of material practice in cultural process, historical studies can simultaneously engage phenomena that we analytically parse as landscape, objects, bodies and minds** (…). From this perspective the material things that have so often been treated as ancillary to historical studies are instead viewed as sources of insight into the practices through which culture was—and is—actively produced (Stahl 2010, 154)

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During the civil wars in the eighteenth-century Kingdom of Kongo, the prophetess Kimpa Vita famously taught that, unlike white men, “Blacks had their origin from a tree called *musanda*, the bark of which they make into ropes and cloth in which they dress and, thus, become black, which is the color of the bark” (Filesi 1972).[1] Amidst political violence and widespread enslavement, Dona Beatriz Kimpa Vita was an aristocratic public healer (*Nganga marinda*) who led a popular movement to restore the kingdom and its former glories (Thornton 1998). Possessed by Saint Anthony, Kimpa Vita reinterpreted the history and theology of the Church from the Kongolese perspective, drawing on her knowledge about the *musanda* to explain the ontological differences she perceived between Africans and Europeans. In Kikongo, *musanda* refers to the *Ficus thonningii*, a species of fig tree that grows in both savanna woodlands and rainforests and might have its deep origins in eastern Africa (Rønsted et al. 2007). Travelers, missionaries, and scholars have long noted that the tree was used not only as a source for barkcloth—the fabric of commoners—but also as a sacred tree of great ritual significance for Lower Congo peoples (Laman 1973; MacGaffey 1986, 2000; Slenes 2007). The tree was associated with prosperity, protection and power and was used in rituals for the foundation of new villages or the installation of new chiefs. Its most important role was to mediate the relationship between tutelary spirits (*basimbi*) of the land and newcomers, which is why the *musanda* was also understood as the source of chiefly power (MacGaffey 2000).

Scholars who have uncovered these meanings have usually interpreted the *musanda* as a metaphorical representation of kinship grounded in the basic analogy between trees and human beings (Gonçalves 1985; MacGaffey 1986; Slenes 2007). These approaches make two assumptions: (1) an ontological priority of language over bodily practices in meaning-making processes; (2) an essential separation between humanity and nature, because a metaphor is necessarily based on an analogy between two different domains. This chapter moves away from such assumptions to foreground the historical process through which the tree became an important sign in Lower Congo societies. It proposes that, if we want to understand how Kimpa Vita mobilized common meanings surrounding the *musanda*, we should place this fragment of discourse in relation to a long-term regional history about how Lower Congo peoples *engaged* with the tree. Such an approach offers new insights into the relation between ontology and environment in an important region of Central Africa.

Lower Congo peoples are Bantu-speaking communities who descended from a common speech community near the Batéké plateau around 500 B.C.E. (De Schryver et al. 2015; Bostoen et al. 2015). Because the peoples living in the rich lands surrounding the Lower Congo river were oral societies for most of their pasts, historical linguistics and archaeology play an important role in illuminating the historical trajectory of human-environment relations in the area. Indeed, a recent synthesis correlating linguistic, archaeological and paleoclimatic evidence suggests

[1] The original is a manuscript in Italian, “Relazioni del ultime Guerra civili del Regno del Congo,” written in 1711 by the capuchin missionary Bernardo da Gallo. “I Negri l’hebbero da un’albero chiamato musanda, della scorza, ò corteccia del qual’albero eglino ne fanno corde, e panni de cuoprirsi, e vestirsi, e perciò sono negri, o del colore di detta scorza.” Translation to English is mine.

that the migration of Bantu-speaking communities into Central Africa followed the climate-induced openings of savanna corridors at the heart of the equatorial rainforest (Bostoen et al. 2015). Early Bantu speakers favored those more open landscapes because their subsistence systems revolved around the exploitation of fruit trees, root crops and possibly the growth of pearl millet, all of which preferred savanna-like environments (Kahlheber et al. 2009; Neumann et al. 2012; Kahlheber et al. 2014).

Yet, as historian Kathryn de Luna (2016) argues, any consideration of the relation among settlement, landscape and subsistence systems should also include a research agenda that explores how people mobilized "culturally and historically contingent ideas about settlement and landscape" as they relocated their residences to novel places. Importantly, while studies of specific trees have illuminated the instrumental ways in which early Bantu speakers exploited the environment, de Luna reminds scholars that the old Bantu root for "tree" and "stick" was also entangled with a set of ideas that held particular kinds of vegetation and landscapes populated by spirits and thus endowed with great metaphysical power. This chapter contributes to this research agenda by discussing how the *musanda* as a sacred tree was used in the ritual for the foundation of new villages to establish the condition for engagement between newcomers and terrestrial spirits of newfound lands.

Using historical linguistics, cognitive linguistics, and comparative ethnography, this chapter shows how the tree was known by Bantu speakers from the earliest of times and discusses the social contexts and cognitive mechanisms through which the *musanda* tree became a sacred symbol in the Lower Congo. I suggest that we take seriously the materiality of the tree and the ways in which early Bantu speakers *engaged* with it. As implied by the causal relation between skin and bark established by the prophetess, I argue that the conceptual contiguity between the *Ficus* and ancestors was ancient and motivated by the continuous use by Bantu-speakers of the fig bark as cloth. Besides, this contiguity was also motivated by the tree's perceived quality of increasing soil moisture. As a tree with which Lower Congo peoples constantly engaged throughout millennia, the *Ficus* was marked as a metonymical trace of ancestors negotiating the relationship between the group and its surroundings. Only when we acknowledge the tree's metonymical reference to ancestors can we understand how it became a symbol of more abstract concepts such as PROSPERITY and CHIEFTAINSHIP in the Lower Congo.[2]

In what follows, I discuss linguistic and ethnographic evidence supporting the argumentation sketched above. Cognitive linguistics is well suited to study the dynamics between ontology and environment among oral ancient societies. But first we have to understand the powerful combination of historical linguistics with other methodologies to recover their histories.

[2] In this article, we follow the convention initiated by Lakoff and Johnson (1980) of presenting conceptual domains in small capitals.

9.1 Historical Linguistics and the Early History of Central Africa

Scholars studying early African history sidestep the lack of written records by resorting to an interdisciplinary approach that includes historical linguistics and archaeology and, more recently, paleoclimatic studies and genetics (de Luna et al. 2012). Studies combine these disciplines to respond to the old, broad question of how the Bantu linguistic family came to be spoken across Central and Southern Africa (Oliver 1966; Vansina 1979, 1980, 1995; Ehret 2001a). More recently, historians have also been scaling down the temporal and spatial scope of their research to foreground the complexities of regional histories in sub-Saharan Africa (Vansina 1990; Schoenbrun 1998; Ehret 1998). In both cases, historical linguistics play a crucial role in historical reconstruction. It generates hypotheses and evidence about paths of migration, chronology, food production, material culture and social life. This information is generated following two methods: *linguistic classification* and *lexical reconstruction*.

Linguistic classification establishes the relatedness of modern-day languages, providing evidence about how they diverged over time. Changes in language reflect the agency of speakers and listeners as they deploy and negotiate meanings they learned from their ancestors (Dimmendaal 2011; Winters et al. 2010). The cumulative effect of those interactions over time in every dimension of communication (morphology, syntax, semantics, etc.) transforms languages, which might lead to dialectalization and the emergence of new ones (Vansina 1995). Linguists survey present-day languages in a region to reconstruct the process just described, and they usually model the historical relationship between them in a linguistic tree. Each node of the tree is understood as a speech community. Linguists call it a "Proto-Language" when that speech community does not leave any written records. Thus, when we reconstruct the historical relationship among a group of languages, we also "establish the historical existence of the societies that spoke the languages" (Ehret 2010, 27). Linguistic classifications are powerful tools for historical reconstruction because they provide information about paths of migration and location of ancient speech communities that can be in turn correlated with archaeological evidence (Ehret 2010; Luna et al. 2012).

Once classification is established, the comparative study of contemporary languages provides the opportunity to reconstruct vocabulary surrounding technology, social life, political institutions, and so on (Vansina 1990; Schoenbrun 1998; Ehret 2010). Reconstructed words are inferred from the regularities in sound correspondence and patterns of semantic shift observed in dictionaries of present-day languages (Ehret 2012). Following the comparative method, one can confidently "undo" these changes to propose the earlier state of a word and its evolution over time. As historian David Schoenbrun puts it, the denser these webs of meanings are, "the more we may recognize something about the architecture of the normative values used by east [or Lower Congo] Africans to make moral, phenomenological, and political distinctions."(Schoenbrun 2006, 748)

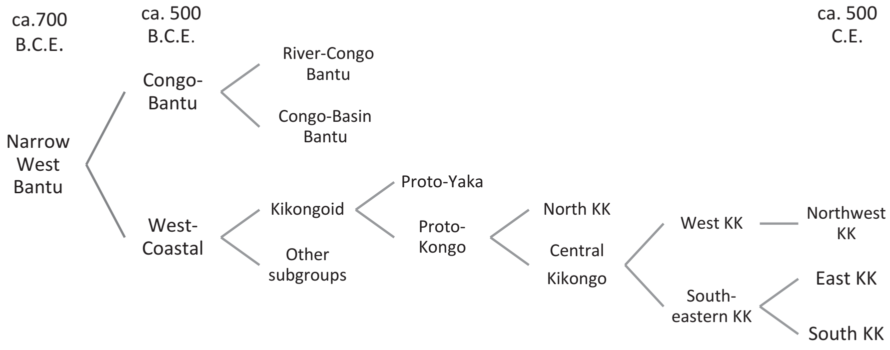

Fig. 9.1 Family Tree of the Narrow-West subbranch of Proto-Bantu. (Adapted from Bostoen et al. (2015) and De Schryver et al. (2015))

Based on historical linguistics, archaeology, and other disciplines, scholars agree that the period around 500 B.C.E. was a thriving moment in Central Africa's long history (Klieman 2003; Bostoen et al. 2015; Ehret 2015). By then, Bantu-speaking communities coming from the northwest had settled along the Congo river following the opening of secondary vegetation at the core of what was once closed-canopy evergreen vegetation (Bostoen et al. 2015; Bostoen et al. 2013). Indeed, the perturbation of Central African rainforest due to climate change favored the southward migration of some Bantu speakers toward the Batéké plateau while others moved eastward toward the Congo-Ubangi confluence area. As their paths diverged, they developed new Bantu varieties, which linguists call West-Coastal Bantu and Congo Bantu, respectively. The overall classification of Narrow-West Bantu can be depicted as a tree (Fig. 9.1).

According to archaeological findings, these linguistic divergences occurred amidst a period of exciting material change: by 500 B.C.E., archaeological sites document a period of densification in villages, the rapid diffusion of metallurgy in Central Africa and, notably, the cultivation of pearl millet (Kahlheber et al. 2009; Oslisly et al. 2013; Bostoen et al. 2015). This rapid material change was driven by an existing network of interactions among communities pursuing different lifestyles, which in turn fostered economic specialization, linguistic differentiation and the spread of Bantu-speaking populations to other areas (Klieman 2003).

Amidst these changes, the West-Coastal Bantu speech community quickly dissolved into other languages in the northern banks of the great Malebo pool. One of these offshoots, a speech community we label as Proto-Kongo-Yaka (Or Kikongoid), became the direct ancestor of all modern-day Lower Congo languages up to its eastern limits in the Kwango River. Based on the parsimonious interpretation of linguistic classification, linguists infer that the spread of Bantu languages in this area involved population movements. Around 500 B.C.E., some Proto-Kongo-Yaka speakers moved around the pool southward to settle down the upper Kwango river, where their language drifted away into a new proto-language, Proto-Yaka (the ancestor of modern-day languages, such as Yaka, Suku, Hungan, and Saamba). Meanwhile, Proto-Kongo speakers headed to the Lower Congo, following the Congo river westward. These Bantu-speakers occupied the region through a series of subsequent linguistic splits all the way down to the wide mouth of the river. By 500 C.E., the offshoots of Proto-Kongo had already diverged into different speech communities: Proto-North, Proto-West, Proto-South and Proto-East (De Schryver et al. 2015).

In the first millennium B.C.E., Bantu-speaking villagers held two related ideologies: the ideology of the village and the ideology of first comers (Vansina 1990; Klieman 2003). Indeed, the village was the most important territorial unit among these Bantu speakers, as leaders of different households built their houses around a "plaza" in the name of common protection (Vansina 1990). As a social unit, the village was led by the leader of the founding household, who dispensed justice through palavers in that same "plaza." Yet, villages were also ephemeral units. Besides the political challenges of keeping people together, Bantu-speaking farmers had to relocate their dwellings into new sites because of the land-extensive strategies they pursued as a lifestyle (Morin-Rivat et al. 2016). However, as historian Jan Vansina suggests, the ephemeral nature of villages contrasted vividly with the villagers' ideology. For them, the village was a perennial unit because it was a continuation of the former village and its territorial rights. However, these ancient Bantu-speaking farming societies found new lands already inhabited by hunter-gatherers they called *-*twa* and understood them to be the original "owners of the land." At the core of this set of ideas was the belief that Bantu-speaking settlers had to appease territorial spirits who were ultimately the ancestors of the first-comers. Consequently, Bantu-speaking settlers reputed these first-comers as possessing knowledge about local spirits, techniques, and environments that made them highly significant to the health and wealth of their communities (Klieman 2003).

The *Ficus thonningii* was literally central to practices and discourses around the foundation of new villages, the ideology of villagers, and the appeasement of territorial spirits. Indeed, the *Ficus* was *the* "plaza" around which villagers built their homes. To understand how early Bantu speakers made the tree the focus of so much attention, however, one needs to understand how they *engaged with* it: using it as source of fiber for barkcloth and acknowledging its agency in assuring security and wealth to its surroundings. Word reconstruction, comparative ethnography, and cognitive linguistics show the historical depth of human engagement with the *Ficus* and how such engagement prompted the emergence of a set of metaphors and embodied practices surrounding the health and wealth of the village. A conceptual metonymy bridged the gap between physical experience and imagination, by grounding their ideas of prosperity and security in a tree that *stood* for their ancestors. In the first millennia B.C.E., this set of beliefs and practices were at the heart of the village's ideology, promoting the cohesiveness of a face-to-face community and its migrations to new lands.

9.2 Linguistic Evidence for *Ficus thonningii Bl.* in the Early Bantuphone World (1500 B.C.E.–500 B.C.E.)

Ficus thonningii is still a poorly understood species among botanists as they still debate what should be circumscribed under the term. Within its particular subsection, many entities have been considered synonyms or closely related to the species described as *Ficus thonningii*, which led some biologists to describe it as a complex of similar species. The *thonningii* complex originated in Eastern Africa millions of years ago, but it spread widely in Central Africa and can be found in savanna and forest environments as far north as Senegal. Typically, this evergreen tree grows as high as 21 meters and develops a dense crown on the top. Known as a strangler tree, it has aerial roots hanging down from branches that can swallow the host tree, but people often grow it alone from sticks put in as cuttings. Once grown, the towering tree exudes a milky sap, and it has the capacity to conserve soil moisture and increase soil fertility (Rønsted et al. 2007).

How did early Bantu speakers reduce the physical reality of the *Ficus* into meaningful categories they could grasp? The multitude of terms associated with this tree in modern-day languages of Equatorial Africa implies a complicated history in the last centuries that goes beyond the scope of this work. Bad identification aside, it is possible that the instability of lexicon referring to the *Ficus* is a direct outcome of the shifting ways in which Bantu-speaking communities engaged with it. Besides, many words were created and crisscrossed speech communities as cloth became a commodity bartered by neighboring villagers. Amidst the labyrinth of names, however, a reanalysis of three reconstructed terms provides clear-cut linguistic evidence showing that the *Ficus* was known by at least one of the earliest Bantuphone communities. These reconstructed terms are *-**gumo**, *-**tɔngo** and *-**cánda**, which is the root of the Kikongo word *musanda*.

The first term can be reconstructed as *-**gumo**. As shown in Table 9.1, attestations of this term are found scattered in modern-day Bantu languages very distant from each other, such as Benga (in Gabon), Lokumo (DRC) and Kikuyu (Kenya). Besides, the phonetic shape of each attestation is regular, pointing to the fact that they underwent the regular sound changes their languages were subjected through history. Together, scattered distribution and regular sound changes are strong evidence that we are dealing with a term that was inherited by all modern-day languages in which it was found. That gives the word considerable antiquity because the most recent shared ancestor of all those languages is a primary offshoot of Proto-Bantu, a language spoken in central Cameroon around 2000 B.C.E. Besides, evidence gathered shows that the term consistently refers to two species: *Ficus hochsterri* and *Ficus thonningii*. This is largely because Raponda-Walker (1961)

Table 9.1 Three Comparative Series of Bantu Names for *Ficus thonningii Bl*

Reconstructed word	Language	Term	Referent	Sources
*-gumo	Benga (A34)	Ikumu	*F. hochsterri*	Raponda-Walker (1961)
	Mpongwe (B11a)	Ogumu	*F. hochsterri*	Raponda-Walker (1961)
	Galwa (B11c)	Ogumu	*F. hochsterri*	Raponda-Walker (1961)
	Nkomi (B11e)	Ogumu	*F. hochsterri*	Raponda-Walker (1961)
	Bongwe (B30)	Mugumu	*F. hochsterri*	Raponda-Walker (1961)
	Ngwi (B861)	Ekum	*Ficus thonningii Bl.*	Muluwa & Bostoen (2015)
	Nzadi (B865)	Okumu	*Ficus thonningii Bl.*	Muluwa & Bostoen (2015)
	Mongo (C61b)	Lokumo	*Ficus* sp. (strangler tree)	Christian Missionary Society (1913)
	KiKuyu (E50)	Mugumo	*Ficus thonningii Bl.*	Karangi (2008)
*-tɔngo				
	Fang (A75)	Elon	*Erythrophleum guineense*	Oyee (1990)
	Fang (A75)	*-tɔngo	*Ficus thonningii Bl.*, barkcloth	Vansina (1990)
	Nkomi (B11e)	Ntóngó	*Ficus thonningii Bl.*, barkcloth	Raponda-Walker (1961)
	Vyia (B301)	Ø-tòngo	*Ficus thonningii Bl.*	Van der Veen & Bodinga-bwa-Bodinga (2002)
	Nzabi (B52)	*-tɔngo	Barkcloth	Vansina (1990)
	Mbede (B63)	*-tɔngo	Barkcloth	Vansina (1990)
	Ndumu (B63)	Tóngó	*Ficus thonningii Bl.*	Raponda-Walker (1961)
	Ndumu (B63)	*-tɔngo	Barkcloth	Vansina (1990)
	Mbati (C13)	*-tɔngo	Barkcloth	Vansina (1990)
	Ngando (C63)	*-tɔngo	Barkcloth	Vansina (1990)
*-cánda				
*-cánd-“Become Numerous, Become Long”	Yaka (H31)	Nsáánda (borrowing)	Arbre (village)	Ruttenberg (2000)

(continued)

Table 9.1 (continued)

Reconstructed word	Language	Term	Referent	Sources
	Ntandu (H16g)	Nsáánda	*Ficus thonningii Bl.*	Daeleman and Pauwels (1983)
	KisiKongo (H16a)	Nsanda	Banyan tree (Ficus generic)	Bentley (1887)
	Yombe (H16c)	Nsanda	*Ficus*	Bittremieux (1922)
	Vili (H12a)	Nsanda	Espèce de Ficus	Derouet (1896)
	Lumbu (B44)	Dintsanda; tsanda	*F. hochsterri*	Raponda-Walker (1961)
	Punu (B44)	Tsàndá (5/6)	*F. hochsterri*	Blanchon (2008)
	Punu (B44)	Tsààndà (9/6)	Cloth	Blanchon (2008)
	Sira (B41)	Gindjanda	*F. hochsterri*	Raponda-Walker (1961)
	Kunyi (H13)	Tsanda	Cloth	Lumwamu (1974)
	Laadi (H16f)	Nsààndá	*Ficus thonningii Bl.*	Jacquot (1982)
	Beembe (H11)	Ntsáánda	Cloth	Kouarata (2010)
	Vyia (B301)	Ø-tsàndá (borrowing)	Cloth	Van der Veen & Bodinga-bwa-Bodinga (2002)
	Iyaa (B73)	Tsáándà (borrowing)	Cloth	Mouandza (2001)
	Umbundu (R11)	Ochisanda (borrowing)	Palm-tree	Le Guennec and Valente (1972)
	Kimbundu (H21)	Musánda (borrowing)	Erythrophleum guineense/*Ficus*	Assis Junior (1940)

understood these names referring to two different species. However, botanists associated with the African Plant Database have since established that *Ficus hochsterri* is simply a synonym for the *Ficus thonningii* (African Plant Database (n.d.).[3] Thus, from a historical point of view, ***-gumo** shows that very early on Proto-Bantu speakers already knew the strangler Fig-tree before some of them took the path toward Central Africa. The term itself could be older than Proto-Bantu if we find attestation in related non-Bantu languages belonging to the Benue-Congo linguistic family, from which Bantu is just one offshoot. However, the term gives us no clue about how early Bantu speakers engaged with it.

The term ***-tɔngo**, however, might attest to the considerable antiquity of the *Ficus* as a source of barkcloth (Vansina 1990). The distribution of modern-day cognates in three subgroups (Northwest, West-Coastal and Congo Bantu) suggests that Bantu-speaking villagers probably knew the word ***-tɔngo** around 1000 B.C.E. as they settled the Cameroonian lowlands. However, the present data do not allow a more rigorous phonological study. Attestation in Mpongwe is phonetically regular,

[3] http://www.ville-ge.ch/musinfo/bd/cjb/africa/details.php?langue=an&id=24390 Online Access: March/2017.

but it refers to *Erythrophleum guineense*. If this word is really a cognate of ***-tɔngo**, then we would need to explain the semantic shift from *Erythrophleum guineense* to the *Ficus thonningii*. The fact that *Erythrophleum guineense* is known for the medical capacities of its bark might provide a clue, although it is not self-evident how the medicinal use of a bark of a tree might prompt speakers to extend the meaning of the word to encompass the barkcloth of a different species. Alternatively, ***-tɔngo** might be the direct outcome of old transfers between Bantu-speaking communities. What is certain is that the term refers to this *Ficus* as well as to its barkcloth and the semantic extension can easily be explained through pragmatic inference triggered by metonymical thinking. That is, as people resorted to the *Ficus* to make the barkcloth, they used the conventional name of the tree to stand for the cloth they wore.

By the close of the last millennium B.C.E., as Proto-Kongo speakers diverged from their older Kongo-Yaka community around the Batéké Plateau, they invented a new term for the *Ficus*, which can be reconstructed as ***-cánda** *(3/4)*. Present-day attestations of this term are found in almost every language of the Kongo group and in some neighboring languages. This distribution of cognates highly suggests that the term was innovated by Proto-Kongo speakers and then borrowed in the following centuries by neighboring communities. Indeed, phonology attests to this. Despite their close linguistic relationship with Lower Congo languages, the term *nsáánda* among Yaka speakers is phonologically irregular, suggesting that it was a borrowing from East Kongo speakers during a period *after* their divergence took place. In neighboring languages in the northeast such as Viya and Teke-Iyaa, attestations are also phonologically irregular and refer only to "cloth." They were likely borrowed from languages descending from an offshoot of Proto-Kongo, North Kongo, where the term also meant "barkcloth." South of the Lower Congo, in Central and Southern Angola, reflexes of ***-cánda** are only found in Kimbundu and Umbundu and refers to the *Ficus* itself or palm-trees, which again suggests that the term was borrowed rather than inherited. Thus, ***-cánda** *(3/4)* is a lexical innovation of Kongo speakers before this community began to diverge into other speech communities.

What might have prompted speakers to rename something they already knew? Changes in the social world often trigger lexical innovation. Etymology, in this regard, offers us invaluable historical information about this moment of intellectual creativity for it tells something about the semantic material speakers were mobilizing as they crafted a new word. In this case, Proto-Kongo villagers drew on the verb *-cánd "To become long, to become numerous" to make the noun ***-cánda** (3/4), thus underscoring the capacity of the *Ficus* to ensure prosperity.[4] They worked out this meaning during a period of village densification, experimentation with cereal agriculture and economic specialization in Central Africa sometime after 500 B.C.E. The remarkable simultaneity between lexical innovation and material change

[4] The other possibility is *-cànd 'turn over, to alter', but the tone in its first vowel is not in agreement with the proposed lexical reconstruction. The overall distribution of the verb *-cánd 'Become numerous, become long' as it is known today is patchy but has a wider occurrence than the noun. See Guthrie, 1970, V.3., 83.

suggests that the *Ficus* was central to the ways in which Kongo speakers coped with the new modes of wealth they themselves were generating.

Although much more research is needed on the vocabulary surrounding the *Ficus thonningii*, evidence presented here shows that (1) the tree was known at least by very early Bantu speakers and maybe earlier and that (2) they very likely used it as a source of barkcloth. After 500 B.C.E., (3) the community of proto-Kongo speakers somewhere near the Batéké Plateau innovated a word for the *Ficus* they already knew, highlighting, at a moment of material change, the ways in which the tree was implicated in the collective well-being of villagers. Yet, the flat gloss glimpsed through etymology tells us nothing about the embodied practices, theories of causality and the ontological realms entangled in the ways Kongo speakers engaged with the tree. Comparative ethnography partially fills this void: it shows how the verbalized representation devised by Kongo speakers was not simply arbitrarily imposed upon the tree, but it grew out of a set of daily or ritualized practices that marked the *Ficus* as the focus of so much attention throughout millennia in the Lower Congo.

9.3 Comparative Ethnography of Bantu-Speaking Communities' Engagement with the *Ficus thonningii*

Bantu-speaking communities used different parts of the tree for a variety of purposes, such as preparing medicines with its leaves or using its latex for birdlime. But, habitually, the tree was known for providing barkcloth. Unlike *raffia* cloth, a symbol of luxury, barkcloth was used throughout Central Africa as the cloth of commoners. People sliced a strip of bark to make the fiber and produce the cloth. In ritualized contexts, however, the tree was used to assure the prosperity of the land, the fertility of the people and the security of villagers. The tree stood in the center of the village, and it was the first tree planted after migration. Ethnography in Central Africa thus shows that the tree was used in key events of social change as well as in daily life. Like historical linguistics, historians of Africa using comparative ethnography read time as a function of space: the distribution of a bundle of cultural practices among sub-groups of a linguistic family gives an approximate idea of its relative historical depth within the linguistic classification (Sapir, [1916] (1985); Vansina 1990; Schoenbrun 1998). Although it cannot be used alone as a source of history, comparative ethnography provides the historian with the social contexts in which people produce and encounter meanings attached to words and things (Schoenbrun 2012). It tells us about the frequency of such encounters by communities of speakers and thus about its conventionalization and reproduction over time (Winters et al. 2010). When recurrent cultural practices are associated with reconstructed words then one feels fairly secure in understanding these associations to be old retentions rather than recent borrowings or independent innovations. Although this cannot be done to reconstructed terms such as ***-gumo** and ***-tɔngo**, there is sufficient ethnographic information to understand the engagement of Proto-Kongo speakers with the *Ficus thonningii* they named ***-cánda**.

There is, however, evidence to suggest that the association of the *Ficus* with ancestry and the possession of the land, on the one hand, and protection and prosperity, on the other, predates the development of Proto-Bantu 4,000 years ago. For example, among the Bamileke, a bantoid-speaking group inhabiting the highlands of Cameroon, the tree is associated with the appropriation of the space. Known as *àtsià nzho*, the *Ficus* assured the sacred right of use for successive heirs of the ancestor's land. As such, the founder of a new village had to collect a *Ficus* cutting of his lineage to plant in the new land. Indeed, every new land was possessed only if the cutting took root, which was a sign that ancestral spirits protected the new compound (Gautier 1996). This custom recalls Bantu-speaking practices in eastern and western Savannas. Among the Kikuyu of Kenya, in East Africa, the *mugumo* (from the root ***-gumo**) is a sacred tree associated with protection and prosperity because it is the place of gift exchange between people and the *Ngai*, the owner and source of life. As a shrine, it was under a *mugumo* that people used to ask for abundant food, peace and protection against evil and witchcraft. It was also planted to demarcate land boundaries and to signal the land's possession by the rightful heirs (Karangi 2008). In the Western-Savannas of central and eastern Angola, where the tree was called *mulemba*, the tree was planted at the center of every village from a cutting of a previous tree. It was the source of chiefly power and its most powerful symbol (Miller 1976; Slenes 2007). Interestingly, the word for the tree among local Bantu-speaking groups there shares the same root with words for "birdlime," "cool, shady place," and "ancestor, grandparent, elder," suggesting a range of meanings and experiences with which the tree was associated (Vansina 2004, 239). Among the Bantu-speaking population of the Middle Kwilu, descendants of a West-Coastal offshoot, the tree was called *-sóng "The one who shows," and it was planted first and foremost in the middle of the village from a previous branch and held similar protective and ritualistic powers as found elsewhere (Muluwa 2010, 387-8).

It is among the Kongo-Yaka linguistic subgroup that we have a wealth of material for an analysis of the ways in which speakers engaged with the *Ficus thonningii*, because they provide linguistic, ethnographic and historical data about the many kinds of engagements and about the ritual and places in which those engagements took place. Early missionaries and travelers in the sixteenth and seventeenth century first encountered the tree as a source of protective cloth and the place where the chief and the kings dispensed justice to the people (Cavazzi, 1732 [1687]; Battell (1901 [1625]). Indeed, at the courtyard of the Palace of the King of Kongo in the sacred capital of Mbanza Kongo lies a *Nsanda* tree where judgments were held and where the first Kongo king is believed to be buried (Pastre 2016). Still today the tree is seen with great respect and deference (Fieldwork 2014). In other powerful monarchies of the Lower Congo, such as Loango and Ngoyo, the tree was also associated with royal power (Volavka 1998, 70). The tree, however, could also be encountered in the forests, rocky borders of rivers, or at crossroads and markets outside villages. Among the BaYombe, the tree in the forest was understood to be a trace indicating a deserted village left by the ancestors (*Bakulu*) (Bittremieux 1922).

Common among all these examples is the association of the tree with ancestral spirits, dislocation, settlement and land tenure. In the Lower Congo, ancestors were not visible anymore, but they did not cease to exist. They went on to inhabit the world of the dead, which Lower Congo people understood to be located in the underground, bodies of water, or the forest, all places that stood in sharp opposition to villages, established in cleared dry land surfaces (MacGaffey 1986). As ancestors of villagers, *Bakulu* were benevolent spirits whose descendants must placate in order to receive their blessings (MacGaffey 1986). Once remembered and appeased, their range of efficacy lay in assuring the condition for growth for their descendants. In this reciprocating cosmology, cemeteries became a special place of exchange between the world of the living and the world of the dead, providing a link between the past generations and the present, and legitimizing the right of the community to the land.

The relation of the *Ficus thonningii* with ancestral spirits, dislocation, and settlement is also found among the Yaka-speaking groups of the Kwango River, from which we have a lengthy description by the Jesuit priest L. Beir in his book *Religion and Magie des Bayakas* (1975). Although the phonological shape of the word suggests that the word was a borrowing from East Kongo speakers, the tree, as in other parts of Equatorial Africa, was planted during the ceremony of *tsiinda hata*, an ancient village medicine prepared by a specialist healer in order to ensure the protection of the villagers against foreign witches, the success of hunting and the general well-being (Vansina 1990, 80; Brausch 1951, 90). The healer was in charge of revealing where a new cutting of the tree should be placed in the foundation of a new village. Once preparations were made, the healer dug a pit on the center of the new village to place the medicine, just next to the chief's new compound. The medicine was a bundle of powerful objects activated by the speech of healers and villagers alike. They went on to sing:

Tukolá khoonzu Qu'on se sente Vigoreux
Tukolá ngolo Qu'on se sente fort
Tsula mbi: izila Mauvais Goût: Tabou
Ndosi a mbí: izíla Mauvais Rêve: Tabou
Isiizí: izíla souche à laquelle on se blesse: tabou
Baawu dímbi: izíla Mauvais Fiévre: Tabou
Beetó Tukóla Que Tous nous nous portions bien
Beetó ye Bakheénto Nous et nos femmes
Báána: batsyáaka Chez les enfants, le sorciers se dispersent
Batékolo: batsáála Chez les petit-enfants, qu'ils restent. (...) (Beir 1975, 75)

Yet, it was the chief who planted the *nsaanda* cutting at the end of the ceremony. This cutting comes from the *nsaanda* tree of the previous village where it was planted "at the place where the ancients were buried" (Beir 1975, 73). As a ritual, the *tsiinda hata* strengthened the bond between supplicants and reinforced the hierarchy between them, thus assuring the reproduction of an old social order in a new location.

Given the widespread importance of the tree among peoples of Equatorial Africa, it perhaps comes with no surprise that fugitive enslaved Africans, in Africa and in

Fig. 9.2 The "tree of the Portuguese," a giant *Ficus thonningii* planted by slaves near Libreville, Gabon (apud: Walkers and Sillans 1961, 297); Illus. Courtesy of the Raponda-Walker Foundation

the Americas, also resorted to the agency of the tree to ensure the well-being of their maroon communities. Indeed, the tree embodied a set of social values and world-views that was reproduced among enslaved Africans in nineteenth-century south-eastern Brazil (Slenes 2007). In Cuba, the ethnographer Lydia Cabrera, working with descendants of maroon communities in the island, recorded that there the word *nsanda* referred to "plaza" as well as "market" (Cabrera 1984). But the clinching evidence comes from Gabon itself: in the outskirts of Libreville lies at huge *Ficus thonningii* known as the "Tree of the Portuguese" that was planted by fugitive slaves escaping the islands of Saint Thomé (Walkers and Sillans 1961) (Fig. 9.2).

In short, although not part of their subsistence system, Bantu-speaking communities explored almost every part of the *Ficus thonningii*. Bark, leaves, and latex were used for clothing, medicine and hunting. Besides, the custom of planting a cutting from a *Ficus thonningii* to establish possession of the land occurs among communities speaking Bantu languages from different subgroups (Savanna Languages, West-Coastal, Kongo-Yaka), with an occurrence among a Bantoid-speaking group of central Cameroon. The antiquity of this engagement with the tree is in broad accordance with linguistic evidence. Hence, with all likelihood, we might suggest that the use of the *Ficus* as a token for land tenure predated the word ***-cánda** and prompted its creation.

Yet, this engagement was not simply seen as the exploration by human beings of raw material from an inanimate object. On the contrary, in a world where people perceived trees and lands as populated by spirits and saturated with personal powers, the most resourceful quality of the *Ficus* was its own agency: it established the condition for growth. But where does such agency come from? Indeed, as John Janzen and others have noted, "as in many other realms of Western Equatorial African culture, a pragmatic rationale seems to have been integrated with a spirit cosmology." (Janzen 2012, 8). Villagers settling a new land had to appease the *basimbi*, the tutelary spirits of the land who were the most ancient ancestors of the first inhabitants of the land. The *basimbi* lived in forests, rocks, and rivers, but they were primarily associated with water. Embodying the power of ancestors to make things grow in its surroundings, the *nsanda* tree was planted in order to "receive the acceptance of the *simbi* water spirits" assuring the adequate moisture for other trees. However, there is nothing arbitrary in the choice of the *Ficus* to appease water spirits. Like Janzen suspected, we know now that a pragmatic rationale was integrated with a spirit cosmology because biologists have recently demonstrated how the presence of the *Ficus thonningii* increased soil fertility by positively influencing soil nutrients (Berhe et al. 2013).

The point to be retained here is that practical efficacy derived from the constant engagement with the tree not from disembodied reason. It was the host of sensorimotor experiences and the tree's perceived qualities that bestowed on the *Ficus* its capacity for symbolization. Between social experience and sacred symbol there was a host of conceptual metonymies and metaphors that have received little attention so far.

9.4 Physical Contiguity, Metonymy, and Metaphor in the Ritual for the Foundation of New Villages (ca. 500 B.C.E.)

Meaning is a capacious category because it is a complex cognitive process that grows in context of use. More still, as anthropologist Webb Keane argues, it depends upon "basic assumptions about what signs are and how they function in the world" and "what kinds of agentive subjects and acted-upon objects might be found in the world" (Keane 2003, 409, 419; Schoenbrun 2016, 231). Understanding the objectified agency of the *musanda* tree and Kimpa Vita's assertion that ancestors grew out of it requires that we displace the primacy of Western ontology whose point of departure is a dichotomy between nature and culture, on the one hand, and mind and body, on the other. Rather, anthropologist Tim Ingold invites scholars to think that for many "non-western" peoples, apprehending the world is not so much a process of a construction of a viewpoint as it is of engagement; a matter "not of building, but of dwelling"(Ingold 2000, 42). The distinction captures the difference between conceiving meaning-making process as an arbitrary mental projection upon the world and the role of embodied practice, practical knowledge, and materiality in prompting ways of being-in-the-world.

Drawing on this important distinction, Ingold criticizes scholarly works that interpret Central-African hunter-gatherers perception of the environment as fundamentally guided by a metaphor "Forest is a Parent." He worries that interpreting the relationship between hunter-gatherers and forest as mediated by a metaphor takes for granted the separation of human beings and nature into two distinct domains, thus smuggling the western dichotomy again into hunter-gatherers thinking. Rather than a metaphor, Ingold suggests, hunter-gatherers relate to their environments through a *poetics of engagement*, in which the forest is not *like* a parent but it is a *kind* of parent, as they *acknowledge* the agency of non-humans in the world. As Ingold puts it, "environments are constituted in life, not just in thought, and it is only because we live in an environment that we can think at all" (Ingold 2000, 60).

Albeit differently, Central-African farmers also *engaged poetically* with their surroundings. Cognitive semantics opens up this dynamic because people draw from kinds of embodied experiences – a body understood as culturally, biologically and ecologically situated – to apprehend more abstract concepts that can themselves serve to build purely mental categories (Rohrer 2010). Conceptual metaphor is the primary cognitive device of the human mind to perform this task: it allows us to create source domains structured by embodied experiences to understand the more abstract target domain through basic analogies of its features. Although this is largely an unconscious activity, Tim Ingold is right in asserting that people must consciously and conventionally understand these domains as separate, i.e. they cannot be understood to belong in the same superordinate domain (Radden 2000). For example, the conceptual metaphor KNOWING IS SEEING is a primary metaphor because it is directly grounded on everyday experiences linking two different domains, bodily perceptual system and mental reasoning. Thus, one can say simply "I **see** what you are saying" to *mean* "I understand" (Lakoff 1980). This metaphor is ancient among Indo-European-speaking societies, as studies in many languages of this group show that visual data is considered to be the most certain kind of knowledge.[5]

Though less studied, conceptual metonymy is equally important in the process of making meaning (Fernandez 1991; Kövecses 2005; Barcelona 2000). It is a more basic cognitive operation of the human mind because it is grounded in direct physical or casual associations. Unlike metaphors, it is not based on an analogy between two different domains, but rather in a *relation of conceptual contiguity within* the same domain. As a cognitive process, metonymy makes a conceptual entity (e.g., FACE) to provide mental access to another entity inside the same domain (e.g.,

[5] For example, the semantic polysemy of the Proto-Indo-European Reconstruction *weid- can be accounted for in terms of the metaphor UNDERSTANDING IS SEEING: Greek, *eidon* "see," perf. *Oida* "know" (>English idea); English *wise, witness*; Latin, *Video* "see"; Irish *fios* "knowledge" (Sweetser 1990:33).

PERSON) (Lakoff and Johnson 1980)**.** Its vital role is creating conceptual salience, "since the metonymy makes primary a domain that is secondary in the literal meaning" (Panther and Thornburg 2010: 239). It provides understanding by directing the attention to certain aspects. Like conceptual metaphors, conceptual metonymies "structure not just our language but our thoughts, attitudes, and actions" (Lakoff and Johnson 1980, 40). The FACE FOR THE PERSON metonymy, for example, is produced linguistically as well as non-linguistically. The tradition of portraits in our culture is motivated by the underlying metonymy that to know someone is to look at his face.

Conceptual metonymies are often a necessary step to the development of metaphors. Rather than simply reading one thing by another, a metonymy-based metaphor is "a mapping involving two conceptual domains which are grounded in, or can be traced back to, one conceptual domain" (Radden 2000, 94). In other words, conceptual metonymies can *motivate* metaphorical mappings. For example, the ANGER IS THE HEAT OF A FLUID IN A CONTAINER metaphor is *motivated* by a metonymy that takes the physiological effects of anger (increased body heat) *to stand for* this emotion.[6] Thus, metonymies grounded in physical experiences are important features to understand the links between social experience and cultural concepts. Consequently, although primary metaphors and metonymies are basic and universal, complex metonymy-based metaphors are inherently culture-specific. They grow out of the host of embodied practices, practical knowledge and engagement with the surroundings shared by a given collectivity, prompting the development of cultural concepts and ways of being-in-the-world. They thus provide a way of exploring Ingold's concept of *engagement* and *dwelling*, and how they change over time: they provide a social group with a fund of common meanings predicated upon shared and ongoing social experiences and thus susceptible of being innovated, conventionalized, inherited, transferred, dropped or transformed as people face "the persistent, shifting need for reference in the world." (Schoenbrun 2016, 233) Because conceptual metaphor and metonymy can be conventionally instantiated in morphemes, words, gestures and material objects they are amenable to be traced back in time using methods of historical linguistics, archaeology and comparative ethnography (Ortman 2000; Schoenbrun 2016).

More than three thousand years ago, Bantu-speaking villagers dressed in barkcloth and moved their residence at least once in a lifetime. The host of sensorimotors experiences and social relations involved in those activities prompted speakers to draw connections between ontology and settlement. They used habitual operations of the mind to reproduce and elaborate on the very old complex of metaphysical ideas about ancestral spirits they inherited from their Niger-Congo ancestors (Kopytoff 1989; Klieman 2003). At least from the time of early Bantu speakers and perhaps earlier, a conceptual metonymy *THE FICUS THONNINGII* FOR THE ANCESTORS embodied the ontological connections between ancestry and

[6] An example of realization of this particular conceptual metaphor is the sentence "I had reached boiling point." The conceptual metonymy ANGER FOR ITS PHYSIOLOGICAL EFFECTS is "Don't get hot under the collar" (Barcelona, 11).

settlement and was part of an old complex of healing practices. Particularly around 500 B.C.E., Kongo speakers, amidst a host of important material transformations, drew on this inherited conceptual metonymy to propose a metaphor to frame what they understood to be the concept of PROSPERITY: the healthy growth of people and plants alike.

This old complex of healing practices held that while ancestor spirits extended their benevolence only to related living persons, territorial spirits, the ancestors of the first inhabitants of the land, ensured local fertility. The foundation of a village into a new place thus implied the work of local specialists and immigrant leaders to appease both kinds of spirits. At a very early stage of Central African history, the *Ficus thonningii* was the entity marked to establish this transaction because its physical qualities and the ways in which early Bantu speakers engaged with it *motivated* peoples' own identification with the tree. Importantly, the tree established a relation of physical contiguity between the two kinds of beings, living people and spirits. On the one hand, the recurrent use of barkcloth made from the *Ficus* established a relation of physical contiguity between the tree and the people through the sharing of the same envelope. It was the physical contiguity between barkcloth and the human skin that prompted Kimpa Vita to establish a causal relation between the two: Africans are black *because* they wore barkcloth. On the other hand, the *Ficus*' physical capacity to improve soil fertility stood for the benevolent actions of territorial spirits, inviting another causal association: The *Ficus* took root because of the acceptance of territorial spirits.

Physical contiguity and causal associations, in turn, invite metonymical thinking, which is in itself a fundamental link between everyday experience and metaphorical symbols. Identification between the *Ficus* and their spiritual ancestors was metonymic because Bantu speakers did not perceive them to belong to two different domains as in the Western thinking, but rather in one broad superordinate domain, that of entities with vitality. Indeed, this can be seen in the use of noun classes in Bantu languages (Lakoff 1987).[7] Morphologically, nouns in Bantu languages are categorized in classes broadly corresponding to semantic domains (Katamba 2006, 8). Remarkably, one of the classes linguists recognize as class 3 categorizes entities with vitality which are neither human nor prototypical animals. Trees and spirits, therefore, were understood to belong within this same domain (Katamba 2006, 117). Accordingly, the relation between the *Ficus* and ancestral spirits is metonymical because, as entities of a same domain, people could mark the tree to provide access for the ancestors. In the context of the ritual for the foundation of new villages, the host of sensori motor activities, causal associations, and identification that Bantu speakers established with the *Ficus* motivated the emergence of two metonymies. As a resource of the mind, the conceptual metonymy *FICUS THONNINGII* FOR THE ANCESTORS transformed the physical contiguities between people, tree, and the land into a reference to ancestral spirits. This metonymy was instantiated

[7] Indeed, as linguist George Lakoff stresses "Classifier languages— languages where nouns are marked as being members of certain categories—are among the richest sources of data that we have concerning the structure of conceptual categories." (Lakoff 1987, 92).

in the embodied practice of planting the *Ficus* at the center of villages and carrying a branch to a new place as a way of extending the territorial reach of their own ancestors. However, in a world already populated by early first-comers this could only be done by appeasing local territorial spirits. In the final part of the ritual, this idea is grounded in the metonymy THE SUCCESSFUL PLANTING OF A *FICUS THONNINGII* FOR THE ACCEPTANCE OF THE TERRITORIAL SPIRITS. By way of these conceptual metonymies, healers and immigrant leaders marked the tree as the focus of attention in the ritual of new settlements because they understood that the tree was a visible purposeful entity enabling access to the invisible forces that conditioned the well-being of their communities. Indeed, the *Ficus* did not depict ancestors; it made them present.

Around 500 B.C.E., amidst population growth and material change, Proto-Kongo speakers stressed how much the wellness of the community depended upon the mediation between the tree and local spirits, by associating the concept of PROSPERITY with the *Ficus*. To be sure, this was likely not the first time and place in Central Africa that such conceptualization occurred. However, the new word for the *Ficus* innovated by Kongo speakers makes plain that this process was not the work of the disembodied mind. Rather, the new lexical item emerged out of the experiential engagement with the tree. By placing the root **-cánd-** "become long, become numerous" in class 3 to grasp the *Ficus* as *-**cánda** (3/4), Kongo speakers developed the metaphor A VILLAGE BECOMING LARGER IS A NSANDA GROWING UP (a specification of a primary metaphor MORE IS UP) to juxtapose the experience of the *Ficus* growing vertically with the biological reproduction of people. Procreation as a target thus structured the concept of PROSPERITY, but its source domain is drawn from the ordinary knowledge that speakers of Kongo had about the *Ficus*. As we have seen, this knowledge involved the existence of ancestral spirits and territorial spirits, whose relationship was held essential to establish a sphere of nurture. By mobilizing a metaphor PROSPERITY IS THE GROWTH OF A NSANDA in the ritualized context of village foundation, Kongo speakers united ontology and environment, making clear that successful procreation—itself an idealized model of genealogical relatedness between individuals—only unfolded properly amidst an ever ongoing field of harmonized relationships established by different beings and entities (Ingold 2000).

Conceptual metaphor and conceptual metonymy make it possible to link symbolism to the social structure of proto-Kongo speakers in the last millennia B.C.E (MacGaffey 1986). They make it possible to understand how, around 2500 years ago, the ideology of villagers intersected with that of newcomers and were actively produced and reproduced through a host of material practices, embodiment, and lexical creation. In the ritual for the foundation of new villages, they suggest how healers and leaders played with conceptual tropes of the mind to ascribe in a new place the primacy of succession and cohesiveness that structured political life of early Bantu speakers (Fernandez 1991). Indeed, it was through the metonymic manipulation of the association between the *Ficus*, the people, and their ancestors that leaders referenced the authority of their own invisible ancestors, legitimized their succession and extended their territorial rights. Metonymy thus helped leaders to propose the continual existence of villages, in opposition to its transient material nature. At the same time, metaphor creates a more harmonious view of the world by cultivating intimacy and consensus between leaders and followers, since its own formulation works only if it promotes widespread understanding of an idea (Durham and Fernandez 1991, 197-8). Thus, while the metonymy THE FICUS FOR THE ANCESTORS emphasizes hierarchy, the conceptual metaphor PROSPERITY IS THE GROWTH OF A NSANDA cultivates shared experience; while the former takes physical contiguity for succession, the latter conceptualize exchange as the condition for prosperity; while the metonymy made the past present, the metaphor targeted the future. The *Ficus thonningii* was thus a trace and a sign of the ideology of villagers and as such it was literally placed at the center of villages. Presiding over its surroundings, the *Ficus* provided early Bantu speakers with the "sense of permanence, predictability, and security, false in physical reality, but essential for social life. (Vansina 1990, 78-9)."

9.5 Conclusion

> "I placed a Jar in Tennessee,/And round it was, upon a hill./It made the slovenly wilderness/ Surround that hill." Wallace Stevens, *Anecdote of the Jar*

Environment, as Stevens' *Anecdote of the Jar* reminds us, is fundamentally a matter of perspective. Inherently relational and historical, it is "the world as it exists and takes on meaning in relation to me, and that sense it came into existence and undergoes development with me and around me" (Ingold 2000, 20). Recent studies on the relationship between human migration and environment in Central Africa have recently made important advances in understanding the relational development between Bantu-speaking settlers, fruit trees, and expanding savanna-corridors due to climate-induced destruction of the rainforest. Relying on the synchronic and spatial overlapping of different bodies of evidence drawn from multidisciplinary research, these studies framed the human-environment relationship relying on the instrumental logic that is discernable and understandable for the modern observer; that is, they focus on the "presumed challenge of adapting subsistence technologies to new environments" (de Luna 2016, 2). However, the persistent lack of a broader set of reconstructed vocabulary about human-environment relations prevented scholars from incorporating in their explanations of how people in the past perceived their surroundings—a research agenda that is not frivolous, as human perspective is inherently integral to any understanding of how *environment itself* is constituted. Following the path opened by linguists, archaeologists, and paleoclimatologists, historians have been calling attention to this problem, proposing a research agenda that foregrounds the "historically contingent conceptualizations of the constraints and opportunities of every domain of life" (de Luna 2016, 6). Indeed, a deep history of engagement of early Bantu speakers with the *Ficus thonningii* reveals how "constraints" and "opportunities" of new lands were entangled in a complex web of visible and invisible forces that conditioned the social and political life of early Bantu speakers. Besides the instrumental ways in which ancient Bantu speakers engaged with the tree, the *Ficus* utmost importance lay in its perceived qualities of overcoming the ontological challenges that Bantu speakers faced when they migrated. Like the jar in Steven's poem, the *Ficus thonningii* helped early Bantu speakers to domesticate the landscape.

Although the *Ficus* had many uses, meanings, and names throughout millennia, this chapter has focused on the durability of its meanings in a *particular context of use*, the foundation of new villages. The widespread distribution in early colonized communities of its central role in rituals of settlement reveal a "durable bundle of meaning and practice" (Schoenbrun, 2006b) that worked across many different historical contexts over millennia, mainly because individuals aspiring to a healthy and wealthy moral community ultimately agreed in acknowledging the *Ficus*' agency in setting the conditions for a prosper future. However, taking a closer look, this durability is actually made of small incremental changes as people proposed novel forms that became entangled with previous practices and concepts, creatively deploying them alongside new ideas or reshaping speech and practice to explain a current problem (Schoenbrun 1993; Feierman 1990; Smail and Andrew 2013). Having mainly focused on Lower Congo around the middle of the first millennia B.C.E., this chapter explored how proto-Kongo speakers innovated a metaphor out of a durable conceptual metonymy instantiated in embodied practices. Such a new way of talking and thinking about the tree proved to be a durable legacy for Lower Congo peoples.

In the following centuries, individuals in many different parts of the Lower Congo continued to engage with the *Ficus*, steadily reworking their own understanding of the tree, often entangling it with new scales of power, such as chieftainship and kingship, or new forms of migration, such as the trans-Atlantic slave trade. Indeed, one such individual was the prophetess Kimpa Vita. By merely beginning to partially uncover the long history of the *Ficus thonningii* among Bantu-speaking societies, this essay allows us to bring Kimpa Vita's fragment of discourse into sharper relief. By mobilizing a tree of great significance among villagers to explain the ontological difference between Africans and Europeans, she was not simply following the prescriptions of tradition, but rather redeploying an old token and a symbol of moral order that was central to any understanding of well-being in the villages where their followers lived.

References

African Plant Database. Conservatoire et Jardin botaniques de la Ville de Genève and South African National Biodiversity Institute Pretoria (version 3.4.0). http://www.ville-ge.ch/musinfo/bd/cjb/africa/. Accessed in: Mar 2017.

Assis Junior. (1940). *Dicionário Kimbundu-Português, Linguístico, Botânico, Histórico E Corográfico. Seguido de Um Índice Alfabético Dos Nomes Próprios*. Luanda: Argente, Santos & Ca.

Barcelona, A. (2000). *Metaphor and metonymy at the crossroads: A cognitive perspective*. Topics in English Linguistics; 30. Berlin/New York: Mouton de Gruyter.

Battell, A. (1901 [1625]). *The strange adventures of Andrew Battell of Leigh, in Angola and the adjoining regions*. London: Hakluyt Society.

Bentley, W. H. (1887). *Dictionary and Grammar of the Kongo Language, as Spoken at San Salvador, the Ancient Capital of the Old Kongo Empire, West Africa. Compiled and Prepared for the Baptist Mission on the Kongo River, West Africa*. London: Baptist Missionary Society.

Berhe, D. H., Anjulo, A., Abdelkadir, A., & Edwards, S. (2013). Evaluation of the effect of ficus thonningii (Blume) on Soil Physicochemical Properties in Ahferom District of Tigray, Ethiopia. *Journal of Soil Science and Environmental Management, 4*(2), 35–45. https://doi.org/10.5897/JSSEM13.0369.

Bittremieux, L. (1922). *Moyambsch idioticon*. Erasmus: Gent.

Blanchon, J. (2008). Dictionnaire Pounou-Français. (Manuscript).

Bostoen, K., Clist, B., Doumenge, C., Grollemund, R., Hombert, J.-M., Muluwa, J. K., & Maley, J. (2015). Middle to Late Holocene Paleoclimatic Change and the Early Bantu Expansion in the Rain Forests of Western Central Africa. *Current Anthropology, 56*(3). https://doi.org/10.1086/681436.

Brausch, G. E. J.-B. (1951). Polyandrie et 'Mariage Classique' Chez les Bashi Lele (Kasai). *Bulletin De l'Association des Anciens Etudiants de l'Institut Universitaire des Territoires d'Outre-Mer, 2*, 86–101.

Cabrera, L. (1984). *Vocabulario congo: el bantú que se habla en Cuba : español-congo y congo-español*. Florida: Ediciones Universal.

Cavazzi, G. A. (1732). *Relation historique de l'Ethiopie occidentale: contenant la description des royaumes de Congo, Angolle, & Matamba*. Paris: Chez CJB Delespine le fils.

Daeleman, J., & Pauwels, L. (1983). Notes d'ethnobotanique ntándu (Kongo) - Principales plantes de la région de Kisaántu : Noms ntándu et noms scientifiques. *Africana Linguistica, 9*(1), 149–255. https://doi.org/10.3406/aflin.1983.920.

de Beir, L. (1975). *Religion et Magie Des Bayaka (Collectanea Instituti, v. 4)*. St Augustin: Anthropos-Institut.

de Filippo, C., Bostoen, K., Stoneking, M., & Pakendorf, B. (2012). Bringing Together Linguistic and Genetic Evidence to Test the Bantu Expansion. *Proceedings: Biological Sciences, 279*(1741), 3256–3263.

de Luna, K. M., Fleisher, J. B., & McIntosh, S. K. (2012). Thinking Across the African Past: Interdisciplinarity and Early History. *The African Archaeological Review, 29*(2/3), 75–94.

De Schryver, G.-M., Grollemund, R., Branford, S., & Bostoen, K. (2015). Introducing a State-of-the-Art Phylogenetic Classification of the Kikongo Language Cluster. *Africana Linguistica, 21*, 87–162.

Denbow, J. (1990). Congo to Kalahari: Data and Hypotheses about the Political Economy of the Western Stream of the Early Iron Age. *The African Archaeological Review, 8*(January), 139–175.

Derouet, J. (1896). *Dictionnaire Français-Fiote: Dialect Kivili*. Loango: Impr. de la Mission Catholique.

Dimmendaal, G. (2011, January). *Historical Linguistics and the Comparative Study of African Languages*. Amsterdam; Philadelphia: John Benjamins Pub. Co..

Dunham, D., & Fernandez, J. (1991). In J. W. Fernandez (Ed.), *Tropical Dominions. The Figurative Struggle over Domains of Belonging and Apartness in Africa*. Beyond Metaphor: The Theory of Tropes in Anthropology. Stanford University Press.

Ehret, C. (1998). *An African Classical Age: Eastern and Southern Africa in World History 1000 BC to AD 400*. Charlottesville: University of Virginia Press.

Ehret, C. (2001a). Bantu Expansions: Re-Envisioning a Central Problem of Early African History. *The International Journal of African Historical Studies, 34*(1), 5–41. https://doi.org/10.2307/3097285.

Ehret, C. (2010). *History and the Testimony of Language*. Los Angeles: University of California Press.

Ehret, C. (2012). Linguistic Archaeology. *African Archaeological Review, 29*(2), 109–130. https://doi.org/10.1007/s10437-012-9116-x.

Ehret, C. (2015). Bantu History: Big Advance, Although with a Chronological Contradiction. *Proceedings of the National Academy of Sciences of the United States of America, 112*(44), 13428–13429. https://doi.org/10.1073/pnas.1517381112.

Feierman, S. (1990). *Peasant Intellectuals Anthropology and History in Tanzania*. Madison: University of Wisconsin Press.

Filesi, T. (1972). *Nazionalismo E Religione Nel Congo All'inizio Del 1700: La Setta Degli Antoniani. Quaderni Della Rivista Africa 1*. Roma: A. BE. T. E.

Gonçalves, A. C. (1985). *Kongo: Le Lignage Contre L'Etat: Dynamique Politique Kongo Du XVieme Au XVIIieme Siecle*. Instituto De Investigaco Científica Tropical.

Guthrie, M. (1970). *Comparative Bantu: An introduction to the comparative linguistics and pre-history of the Bantu Languages*. Farnborough: Gregg International.

Ingold, T. (2000). *The perception of the environment: Essays on livelihood, dwelling and skill*. In *London*. New York: Routledge.

Jacquot, A. (1982). *Lexique laadi (koongo)*. Paris: O.R.S.T.O.M.

Kahlheber, S., Bostoen, K., & Neumann, K. (2009). Early plant cultivation in the Central African Rain Forest: First Millennium BC Pearl Millet from South Cameroon. *Journal of African Archaeology, 7*(2), 253–272.

Kahlheber, S., Eggert, M. K. H., Seidensticker, D., & Wotzka, H.-P. (2014). Pearl Millet and other plant remains from the Early Iron Age site of Boso-Njafo (Inner Congo Basin, Democratic Republic of the Congo). *African Archaeological Review, 31*(3), 479–512. https://doi.org/10.1007/s10437-014-9168-1.

Karangi, M. M. (2008). Revisiting the Roots of Gĩkũyũ Culture through the Sacred Mũgumo Tree. *Journal of African Cultural Studies, 20*(1), 117–132. https://doi.org/10.1080/13696810802159339.

Katamba, F. (2006). Bantu Nominal Morphology in Nurse, Derek, and Gérard Philippson. In *The Bantu Languages*. London: Routledge.

Klieman, K. A. (2003). *"The Pygmies Were Our Compass": Bantu and Batwa in the History of West Central Africa, Early Times to C. 1900 C.E.* Portsmouth: Heinemann.

Kopytoff, I. (1989). *The African frontier: The reproduction of traditional African societies*. Bloomington: Indiana University Press.

Kouarata, G. N. (2010). *Dictionnaire beembe-français: mukaanda mambaangukulu kibeembe-lumputu*. Première édition. Brazzaville, République du Congo: SIL-Congo Grammatische Analysen afrikanischer Sprachen; Bd. 48. Köln: Rüdiger Köppe Verlag.

Kövecses, Z. (2005). *Metaphor in Culture: Universality and Variation*. Cambridge University Press.

Lakoff, G., & Johnson, M. (1980). *Metaphors We Live by*. Chicago: University of Chicago Press.

Laman, K. E. (Karl Edvard). (1973). Cahiers En Kikongo [Microform].

Le Guennec, G. (1972). *Dicionário português-umbundu*. Luanda: Instituto de Investigação Cientifíca de Angola.

Lumwamu, F. (1974). Elements Pour Un Lexique Kongo-Français (Dialects Dondo-Kamba-Kuni).

MacGaffey, W. (1986). *Religion and Society in Central Africa: The BaKongo of Lower Zaire*. Chicago: University of Chicago Press.

MacGaffey, W. (2000). *Kongo Political Culture: The conceptual challenge of the particular*. Bloomington: Indiana University Press.

Miller, J. C. (1976). *Kings and Kinsmen: The Imbangala Impact on the Mbundu of Angola*. Oxford: Oxford Univ. Press.

Morin-Rivat, J., Biwolé, A., Gorel, A.-P., Vleminckx, J., Gillet, J.-F., Bourland, N., Hardy, O. J., et al. (2016). High spatial resolution of Late-Holocene human activities in the Moist Forests of Central Africa using soil charcoal and charred botanical remains. *The Holocene, 26*(12), 1954–1967 https://doi.org/10.1177/0959683616646184.

Mouandza, J.-D. (2001). *Elements Du Description Du Iyaa (Parler Bantu Du Congo-Brazzaville)*. Université de Nice Sophia Antipolis. (Ph.D. Dissertation).

Muluwa, J. K. (2010). *Plantes, Animaux et Champignons en Langues Bantu: Étude comparée de phytonymes, zoonymes, et myconymes en nsong, ngong, mpiin, mbuun, et Hungan (Bandundu, RD. Congo)*. Université Libre de Bruxelles (Ph.D. Dissertation).

Muluwa, J. K., & Bostoen, K. (2015). *Lexique compare des langues bantu du Kwilu (Republique democratique du Congo): francais-anglais-21 langues bantu (B, C, H, K, L)*. Grammatische Analysen afrikanischer Sprachen; Vol. 48. Köln: Rüdiger Köppe Verlag.

Neumann, K., Bostoen, K., Hohn, A., Kahlheber, S., Ngomanda, A., & Tchiengue, B. (2012). First Farmers in the Central African Rainforest: A View from Southern Cameroon.(Report). *Quaternary International, 249*, 53.

Oliver, R. (1966). The Problem of the Bantu Expansion. *The Journal of African History, 7*(3), 361–376.

Oslisly, R., White, L., Bentaleb, I., Favier, C., Fontugne, M., Gillet, J.-F., & Sebag, D. (2013). Climatic and Cultural Changes in the West Congo Basin Forests over the Past 5000 Years. *Philosophical Transactions of the Royal Society B: Biological Sciences, 368*(1625). https://doi.org/10.1098/rstb.2012.0304.

Oyee, J. B. (1990). *Curso de Lengua Fang*. Madrid: Centro Cultural Hispano-Guineano.

Panther, K.-U., & Thornburg, L. (2010). Metonymy. In D. Geeraerts & H. Cuyckens (Eds.), *The Oxford Handbook of Cognitive Linguistics*. New York: Oxford University Press.

Pastre, B. (2016). *Um Lugar Entre Dois Mundos: Paisagens de Mbanza Kongo*. São Paulo: Universidade de São Paulo (Master Thesis).

Radden, G. (2000). *How Metonymic are Metaphors*? in Barcelona, Antonio. In *Metaphor and Metonymy at the Crossroads: A Cognitive Perspective*. Berlin: Mouton de Gruyter.

Raponda-Walker, A. (1961). *Les plantes utiles du Gabon. Essai d'inventaire et de concordance des noms vernaculaires et scientifiques de plantes spontanées et introduites description des espèces, propriétés utilisations économiques, ethnographiques et artistiques*. Encyclopédie biologique, 56. Paris: P. Lechevalier.

Rohrer, T. (2010). Embodiment and Experientialism. In D. Geeraerts & H. Cuyckens (Eds.), *The Oxford Handbook of Cognitive Linguistics*. New York: Oxford University Press.

Rønsted, N., Salvo, G., & Savolainen, V. (2007). Biogeographical and Phylogenetic Origins of African Fig Species (Ficus Section Galoglychia). *Molecular Phylogenetics and Evolution, 43*(1), 190–201. https://doi.org/10.1016/j.ympev.2006.12.010.

Ruttenberg, P. (2000). *Lexique Yaka-Francais, Francais-Yaka*. München: LINCOM Europa.

Schoenbrun, D. (1993). A past whose time has come: Historical context and history in Eastern Africa's Great Lakes. *History and Theory*, 32–56.

Schoenbrun, D. (1998). *A Green Place, A Good Place: Agrarian change and social identity in the Great Lakes Region to the 15th Century*. Heinemann.

Schoenbrun, D. (2006). Violence and vulnerability in East Africa before 1800 CE: An agenda for research. *History Compass, 4*(5), 741–760. https://doi.org/10.1111/j.1478-0542.2006.00352.x.

Schoenbrun, D. (2006b). Conjuring the modern in Africa: Durability and rupture in histories of public healing between the great Lakes of East Africa. *American Historical Review, 111*(5), 1403–1439.

Schoenbrun, D. (2012). Mixing, moving, making, meaning: Possible futures for the distant past. *The African Archaeological Review, 29*(2/3), 293–317.

Schoenbrun, D. (2016). *Pythons worked. Constellating communities of practice with conceptual metaphor in Northern Lake Victory, ca. A.D. 800 to 1200*. In A. P. Roddick & A. Stahl (Eds.), *Knowledge in motion: Constellations of learning across time and place*. Tucson: The University of Arizona Press.

Slenes, R. W. (2007). L'arbre Nsanda Replanté: Cultes D'affliction Kongo et Identité Des Esclaves de Plantation Dans Le Brésil Du Sud-Est Entre 1810 et 1888. *Cahiers Du Brésil Contemporain, 67*, 217–314.

Smail, D. L., & Andrew, S. (2013). History and the 'Pre'. *The American Historical Review, 118*(3), 709–737. https://doi.org/10.1093/ahr/118.3.709.

Stahl, A. (2010). Material Histories. In D. Hicks & M. Beaudry (Eds.), *The Oxford handbook of material culture studies*. Oxford/New York: Oxford University Press.

Thornton, J. (1998). *The Kongolese Saint Anthony: Dona Beatriz Kimpa Vita and the Antonian Movement, 1684-1706*. New York: Cambridge University Press.

Van der Veen, L. J., & Bodinga-bwa-Bodinga, S. (2002). *Dictionnaire geviya-français*. Leuven: Peeters.

Vansina, J. (1979). Bantu in the Crystal Ball, I. *History in Africa, 6*(January), 287–333. https://doi.org/10.2307/3171750.

Vansina, J. (1980). Bantu in the Crystal Ball, II. *History in Africa, 7*(January), 293–325. https://doi.org/10.2307/3171667.

Vansina, J. M. (1990). *Paths in the rainforests: Toward a history of political tradition in Equatorial Africa*. Madison: University of Wisconsin Press.

Vansina, J. (1995). New Linguistic Evidence and 'the Bantu Expansion. *The Journal of African History, 36*(2), 173–195.

Volavka, Z. (1998). *Crown and ritual: Insignia of Ngoyo*. Toronto: University of Toronto Press.

Winters, M. E., Tissari, H., & Allan, K. (Eds.). (2010). *Historical cognitive linguistics* (1st ed.). Berlin: De Gruyter Mouton.

Chapter 10
The Evolution of Recent Multidisciplinary Deep-Water Archaeological and Biological Research on the Gulf of Mexico Outer Continental Shelf

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Abstract The Bureau of Ocean Energy Management (BOEM) regulates offshore energy development on the Outer Continental Shelf (OCS) of the United States. As part of the environmental review process of permitted industry activities, BOEM requires oil and gas operators to conduct an archaeological and benthic biological geophysical survey and, if necessary, remotely operated vehicle or diver investigations in their areas of operation. We therefore have detailed archaeological data of deep waters of the Gulf of Mexico at a scale much greater than anywhere else in the world. These surveys have identified well over 100 shipwrecks in deep water. In the last couple of decades, BOEM has funded or supported multidisciplinary research on many of these deep-water shipwrecks. Recently, BOEM scientists have designed research projects that treat archaeology, biology, and geochemistry as equal with regard to project goals. By integrating research efforts, new insights and discoveries have been made, for example with regard to biological community structure relative to archaeological material properties and mutual site formation. This chapter synthesizes the evolution of several of these research endeavors and the discoveries that could only have been achieved through this type of integrated multidisciplinary research.

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10.1 Introduction

Unlike most types of terrestrial archaeology, archaeology of submerged resources is usually defined by the medium or matrix in or under which it is discovered—water—and not by material, time period, or region. In its broadest definition, this is referred to, including within the discipline, as underwater archaeology. In the 70 or so years that it has been pursued as a professional science,[1] underwater archaeology has been partitioned into several separate yet often interchangeable areas depending on the scientific focus of the practitioner and the location of the archaeological resource of interest. For example, marine archaeology generally refers to working within a freshwater or saltwater environment. Nautical archaeology deals specifically with shipwrecks and ship construction, whereas maritime archaeology focuses on the social and physical remains of maritime cultures, incorporating archaeological resources both submerged and on land. Essentially, the technology required to conduct archaeological field investigations in a submerged environment differentiates underwater archaeology from terrestrial archaeology.

McManamon (2016) argues that Battista Alberti was the first person to conduct a 'scientific' analysis and recovery of a submerged shipwreck when he attempted to identify and recover one of Caligula's pleasure barges from Lake Nemi for Cardinal Prospero Colonna in 1446. Though he was unsuccessful in recovering the vessel and did not try to preserve the recovered artifacts, Alberti did describe and analyze the material, and published his findings in his greater treatise on architecture *De re aedificatoria*. We can ascribe the first modern full scientific excavation and analysis of a submerged shipwreck to George Bass (1967) and his work on what is known as the Bronze Age Cape Gelidonya Shipwreck in 1960 located off the coast of Turkey. Before this, while archaeologists did inspect submerged sites, most interaction with shipwrecks involved cargo and material salvage.

The ability to access submerged archaeological sites at various depths and in different underwater environments has grown with technological advancements in underwater exploration and engineering. Though most marine technologies are developed for purposes other than archaeology, archaeologists have quickly incorporated these tools into research and recovery. For example, the shipwrecked remains of the *USS Monitor* were discovered off the coast of North Carolina in 1973. It was not until 2002 that archaeologists and engineers decided to recover and begin the conservation process of the vessel's gun turret (Broadwater 2012). Today it is possible to access submerged archaeological resources many miles below the surface using manned submersibles, autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs). Improvements in video, internet, and satellite technology allow scientists real-time global remote access to ongoing research, allowing for both unlimited potential expert participation and the ability to disseminate to the greater public the expedition results as they occur (Ballard 2008).

[1] Beginning with the post–World War II development of SCUBA technology and the pioneering underwater exploration and research by Jacques-Yves Cousteau.

Many, if not most, submerged archaeological resources do differ from their terrestrial counterparts in one aspect. With the exception of some infrastructures purposely interned into the seafloor, such as bridge or wharf pilings, cribbage, or intentionally deposited artifacts, (for example, see Robinson et al. 2017), the majority of underwater archaeological resources, whether prehistoric or historic in origin, were not intended for use while submerged or imbedded within the seafloor.[2] The inundation of these sites was unintentional as a result of natural or anthropogenic factors such as rising sea levels, as with submerged prehistoric sites; flooding, such as that following the construction of a dam to create a reservoir; or accidental and often catastrophic loss.

This is not the case for submerged biological resources. While the origin of all archaeological resources is terrestrial, both aquatic flora and fauna evolved within the underwater environment. As a result, the connectivity between inundated archaeological sites and the aquatic species that utilize them is highly unique, with nothing readily comparable on land. This is especially true below the photic zone, where archaeological resources, in particular, shipwrecks, often act as artificial reefs. These artificial reefs mirror natural hard-bottom areas drawing colonization from microorganisms to mega-fauna. Although recent research has provided new insights into this symbiotic relationship, much remains unknown, especially about the species that use these resources.

Perhaps even more so than on land, the formation of submerged archaeological sites on the seafloor is intimately linked with the environment and ecosystem in which they are located, even more so than terrestrial archaeological sites. Keith Muckelroy (1978) was the first archaeologist to propose that environmental factors affect the transformation of archaeological sites in regular ways that can be elucidated. Muckelroy focused his analysis on physical environmental factors such as the slope and nature of the seabed, including topography and grain size, offshore fetch, and sea horizon. Ward et al. (1999) expanded Muckelroy's ideas to show that an individual submerged archaeological site can undergo site-formation processes through an infinite number of paths to arrive at the state at which it is observed and studied. The authors illustrate how, in physically dynamic environments, geophysical factors play a dominant role in site formation processes and, in passive environments, formation is primarily controlled by biochemical ones.

More recently, site-specific research has considered the effects of biota on submerged archaeological sites in general and even the effects of specific species on individual shipwrecks. The most common of these biological analyses have included the study of corrosion products on metal structures, shipwrecks, and artifacts due to microscopic bacterial colonization (for example, see Macleod 2016 and Sanchez-Porro et al. 2010) and the colonization of wooden structures and objects by species of wood boring mollusks (for example, Gregory 2016).

[2] For ease of narrative, this chapter uses "seafloor" to refer to the sediment matrix in which archaeological resources are either on or embedded regardless of which type of body of water it is under. This may include oceans, bays, estuaries, lakes, ponds, rivers, and so forth.

Like archaeologists who disregard colonial biota on shipwrecks in order to access materials that supply traditional archaeological data, biologists interested in benthic organisms consider submerged archaeological resources as either hard-bottom structures to which sessile species may attach or perishable remains as a temporary food source for both benthic and mobile creatures. Recent research (described below) shows that the composition and structure of submerged archaeological sites influences the formation of benthic community structure. Today it is clear that submerged archaeological sites and benthic communities co-evolve in situ and that their formation processes are tightly linked to one another.

10.2 BOEM and Environmental Science

The Bureau of Ocean Energy Management (BOEM) is a federal agency within the Department of the Interior whose primary mission is to manage the development of fossil and renewable energy and mineral resources on the Outer Continental Shelf (OCS) of the United States. Authorized by the Outer Continental Shelf Lands Act of 1953, BOEM manages over one billion acres of the OCS in the Atlantic and Pacific Oceans, Arctic seas, and in the Gulf of Mexico. The majority of exploratory and extractive activity occurs in the Gulf of Mexico. Active oil and gas exploitation in the federally managed waters of the gulf has occurred since the 1940s. BOEM has three avenues by which it carries out archaeological research as a part of its mandate: environmental protection regulation requirements for the offshore energy and minerals program, the agency's Environmental Studies Program, and partnership research projects for which BOEM archaeologists are recognized as subject matter experts in OCS archaeology. A description of each is provided below.

10.2.1 Environmental Protection Regulation Requirements for the Offshore Energy and Minerals Program

BOEM has required environmental assessment of proposals for permitted activities such as oil and gas exploration and development in the Gulf of Mexico since the late 1970s. Companies submitting proposals are required to assess the expected and potential effects on the human and natural environment from their commercial activities. This includes effects on water quality, air quality, biological and biochemical resources, archaeological resources, and total effects on the coastal zones of adjacent states from ancillary activities such as coastal transportation and port use. Companies are also required to assess the potential for geological risks present in their area of operations such as geological faulting, subsurface gas pockets, and unstable seabed surfaces.

Several environmental statutes, regulations, and executive orders stipulate what environmental analyses and protections must occur. For historic archaeological resources this includes the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA). Overall, commercial activity in general on the OCS is primarily managed by several federal agencies including in addition to BOEM: The Bureau of Safety and Environmental Enforcement (BSEE), The National Oceanic and Atmospheric Administration (NOAA), The U.S. Army Corps of Engineers (ACOE), The Environmental Protection Agency (EPA), and The U.S. Coast Guard.

In order to comply with federal environmental regulations, oil and gas companies hire environmental, geological, and cultural resource management firms to conduct remote sensing and, when required, diver or ROV inspection surveys of their area of operations. BOEM publishes *Notices to Lessees and Operators* that stipulate equipment, methodology, and reporting requirements.[3] As the oil and gas companies purchase long-term leases of areas or blocks, each of typically nine square miles, most choose to have their entire leased areas surveyed and submitted to BOEM as a whole for review. Due to the cost of these environmental and hazard surveys, companies choose to conduct them concurrently, and therefore analyze geological, biological, and archaeological resources together in the same report. A professional archaeologist meeting the Secretary of the Interior's Standard for Archaeology and Historic Preservation conducts the archaeological analysis. As of 2015, approximately 6200 hazard surveys (most of which include archaeology) have been conducted in the Gulf of Mexico.

Because of these surveys, the Gulf of Mexico OCS is the first region in North America where we have enough detailed physical, geological, biological, and archaeological data to be able to analyze and describe a deep-water maritime archaeological landscape, and into which we can situate individual archaeological sites.

10.2.2 The Gulf of Mexico Deep-Water Archaeological Landscape

The Gulf of Mexico and its coastal communities were integrated into the social and commercial Caribbean diaspora from the establishment of European colonies through the nineteenth century. Sailing vessels would enter the Gulf of Mexico from the Caribbean Sea between Campeche and Cuba and make use of the prevailing

[3] For current archaeological requirements see NTL-2005-G07 and NTL-2011-JOINT-G01 (https://www.boem.gov/Environmental-Stewardship/Archaeology/Gulf-of-Mexico-Archaeological-Information.aspx).

Loop Current to circumnavigate the gulf. Sailing vessels from the sixteenth century through the mid-nineteenth century typically participated in one of the following practices in the Gulf of Mexico: exploration, resource extraction, commerce, security, or piracy. Sometimes they did more than one of these at a time.

Primary, large ports established by the eighteenth century included, in sailing order, Vera Cruz, New Orleans, and Havana where ships exited the gulf for the return journey to Europe via the Florida Straits. The most commercially important bulk goods shipped along this route through the nineteenth century include cattle, indigo, and cochineal from New Spain/Mexico; cotton, sugar, and rice from the Mississippi Valley; and sugar, tobacco, and coffee from Cuba. All are, for the most part, organic, perishable goods. The primary current in the Gulf of Mexico, the Loop Current, traverses deep water throughout the route. Though sailing vessels traversed the gulf coast from the beginning, it was not until the nineteenth century, with the advent of steam power and the proliferation of large coastal towns and cities, that a more coastal route circumnavigating the northern Gulf of Mexico was established.

BOEM has identified over 3000 known or potential shipwreck sites in the northern Gulf of Mexico from historical accounts and records, modern wreckage reporting, and through archaeological survey. Not unexpectedly, they are typically situated within a couple hundred miles of the coast as survivability and/or debris washed ashore increased the chance that a vessel loss would be reported. Additionally, it has only been in the last few decades that the oil and gas industry has moved into deep water, increasing the incidence of unexpected site discovery. We use unexpected here to mean that shipwrecks were discovered in locations where there is no evidence for a loss in the immediate vicinity in the historical record.

Figure 10.1 shows the plotted locations of all of the historic shipwreck locations in the northern Gulf of Mexico. Though many shallow sites were located through activities such as fishing, trawling or archaeological research, the majority of deep-water sites were discovered during shallow hazard surveys conducted for the oil and gas industry. What this map illustrates is not that the majority of shipwrecks in deep water are located in the central Gulf of Mexico, but the areas where shipwrecks have been located in relation to oil and gas surveys. It is possible that we would find just as many deep-water shipwrecks in the western gulf if the density of survey increases in that region. Where there is survey data, a large percentage of the deep-water shipwrecks cluster along what amounts to the average Loop Current route through the gulf and along the areas of the main trade winds. However, this map also illustrates that shipwrecks can be found anywhere in the gulf. BOEM's working assumption, and one that has proved useful in managing the deep water of the OCS, is that while the likelihood of a shipwreck's being at any particular location is low, the chance of finding one in a surveyed area is high, and the preservation of these sites is typically excellent.

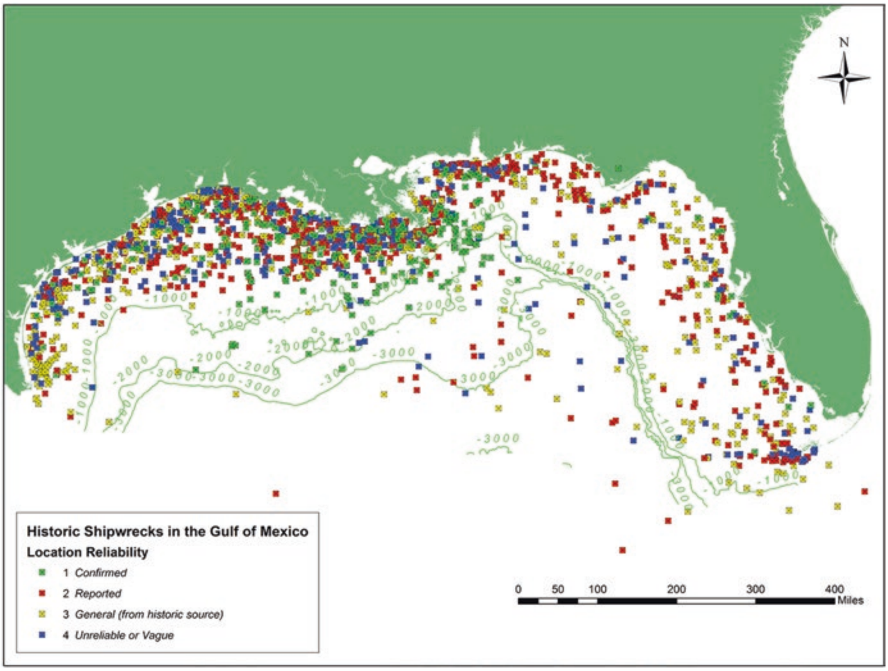

Fig. 10.1 Historic Shipwrecks in the Gulf of Mexico (includes those that have been identified through high-resolution geophysical survey, but have not been ground-truthed)

10.2.3 Environmental Studies Program

Because we can now situate shipwreck archaeological sites into this deep-water landscape, we are able to design multidisciplinary research programs that allow for data and information derived from these sites to begin to answer new questions concerning portions or even the entire socio-environmental, and more specifically, the socio-ecological landscape. This (1) allows us to build a true physical maritime archaeological landscape in which to evaluate issues of preservation and formation processes and (2) provides a holistic context in which to pose interdisciplinary scientific questions regarding the archaeological sites, or to ask questions of another discipline for which a shipwreck is integrated into the subject structure. In the last couple of decades, BOEM has funded or co-sponsored multidisciplinary research on many of these deep-water shipwrecks through its Environmental Studies Program that treats archaeology, biology, geochemistry, and their applicable subfields as equals with regard to project goals. By integrating research efforts, scientists have obtained new insights and made new discoveries; and by pooling a multitude of efforts, have reduced the costs of the projects to an acceptable level. Two of these projects and their results are summarized below.

Fig. 10.2 The Stern of *Robert E. Lee* colonized by several large fly-trap anemones. (Image courtesy of Ocean Exploration Trust, Inc.)

10.2.3.1 Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico

In 2004 BOEM funded a joint archaeological and biological research program to study seven World War II era steel shipwrecks (*Virginia*, *Halo*, *Gulfpenn*, *Robert E. Lee*, *Alcoa Puritan*, *U-166*, and *Anona*) in the Gulf of Mexico (Church et al. 2007) (Fig. 10.2). All but one of the vessels (*Anona*) was lost due to war time activity. Six were lost during the summer of 1942, and *Anona* was lost due to an accident in 1944. The vessels, therefore, can be considered in the context of the wartime landscape of Gulf of Mexico. Since the vessels all sank at approximately the same time, but at different depths and into different environmental contexts, the formation processes of both the shipwrecks and their respective colonial biological communities can be compared and contrasted. Due to adverse weather caused by Tropical Storm Bonny, *Anona* was unable to be investigated. As a result the site assessment was based on ROV imagery collected during initial industry investigations. Most of these seven shipwrecks also contained significant amounts of petroleum products at the time of their loss, with *Virginia* monitored as a potential source of significant pollution by the Coast Guard; therefore, improved knowledge of the structural integrity of these vessels was also of paramount importance.

Project objectives for archaeology included the confirmation of the identity of the shipwrecks and their associated historical attributes (construction date, nationality, use history, cargo, among others); state of preservation; bio-fouling and its relationship to stability, and current environmental impact; extent of the debris fields; and eligibility to the National Register of Historic Places (NRHP). Biological objectives included characterization of the local environment; characterization of the local artificial reef effect created by the shipwrecks, determination of the physical and biological modification of local sediments and its volumetric extent, taxonomic analysis of colonial species, and determination of spatial heterogeneity of both sessile and mobile colonial or visiting organisms (microbial, invertebrate, and vertebrate).

The location of each shipwreck site was previously known, but most had not been extensively studied. For the Deep Wrecks Project, each was systematically surveyed using an acoustically positioned ROV using high-resolution digital video and still camera imagery. All imagery was recorded on tape for later review. The data were used to construct detailed maps of each site. The ROV also carried instrumentation to document water column (temperature, pH, salinity, and so forth) and seafloor substrate (sediment cores) attributes. Traps for large invertebrate and vertebrate species were set at each site and a suction system attached to the ROV was used to collect smaller organisms. Hard-bodied sessile species such as corals and microbial-created "rusticles" were collected with the ROV's manipulator. Metal coupons of varying compositions were set at each site to assess microbial colonization and composition.

The data show that, in general, there was a correlation between the state of preservation of the shipwreck sites and water depth. Sediment cores indicated that the shipwrecks did not appear to be adversely affecting the surrounding surficial seabed sediments. All shipwreck sites were determined eligible to the NRHP. Biological generalizations across the sites include, among others, that the shipwrecks significantly influence the community makeup of invertebrate species, with abundance and richness decreasing with distance from the shipwrecks; associated sedimentary meiofauna decreased with depth; the presence of hard corals increased overall habitat complexity; reef fish communities only occur at shallower sites[4]; and fish communities in deep water in the presence of or away from shipwrecks were similar.

10.2.3.2 Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard-Bottom Habitats, with Emphasis on Coral Communities: Reefs, Rigs, and Wrecks—"Lophelia II"

In 2008, BOEM decided to focus research on a specific species of stony coral, *Lophelia pertusa*, that had been identified on authigenic substrates, offshore oil platforms, and shipwrecks (Brooks et al. 2016) (Fig. 10.3). Instead of archaeological sites being chosen based on their apparent construction type, use type, or age, they were chosen based on the identified presence of the target coral species. They include the wooden sailing vessels the Viosca Knoll Wreck, the 7000 ft. Wreck, the Ewing Bank Wreck, and the Green Lantern Wreck[5] and the steel World War II era

[4] The depths of the seven shipwrecks range from 87 to 1964 m.

[5] The names of the wooden vessels are unknown. These identifiers are related to the location in the

Fig. 10.3 The stempost (primary bow timber) of the Viosca Knoll Wreck covered in *Lophelia*, Stalk Barnacles, *Acesta* clams, and anemones. (Image courtesy of Stephanie Lessard-Pilon using the Aquapix camera, *NOAA: Lophelia II 2009: Deepwater Coral Expedition: Reefs, Rigs and Wrecks*)

vessels *Gulfoil*, *Gulfpenn*, and *U-166*, the latter two vessels being included in the abovementioned study. The focus of the research was to characterize hard substrate communities in which *L. pertusa* is abundant and to determine their potential connection to other coral populations and surrounding communities.

The primary objectives of this multidisciplinary study were biological but included a significant archaeological component as well. The biological research objectives included, among others, developing predictive capability for the occurrence of cnidarian hard-ground communities in deep water; identifying new locations in water depth greater than 300 feet of extensive coral community development; developing an understanding of the controlling mechanisms for the occurrence and distribution of coral communities in deep water; and evaluating the relationship between coral communities and natural versus modern and historic (that is, shipwrecks) anthropogenic substrates including composition, function, population genetics, and growth rates. For the archaeological component, archaeologists were tasked with creating detailed maps of each shipwreck site, collecting data regarding their age and construction, and evaluating site-formation processes. The latter task

Gulf of Mexico in which they were found or a conspicuous feature on the site.

was enhanced by the inclusion of the biological research. This integrated approach provided both the biologists and archaeologists with an opportunity to elucidate particular aspects of individual archaeological sites that affect biological community structure as compared with purposefully interred structures such as offshore oil platforms and naturally occurring hard bottom areas. Additionally, archaeologists had the opportunity to revisit two shipwrecks, *Gulfpenn* and *U-166,* and to evaluate changes in site stability, condition, and formation processes occurring at each.

Data were collected at target locations, including the seven shipwreck sites, during five cruises between 2008 and 2012. High-resolution video, water column data, and biological samples were collected by a several ROVs and an AUV. Sediment flux to the sites was measured with a sediment trap deployed at each site. Archaeological research at each shipwreck site was not considered ancillary to the biological work. Each shipwreck site was systematically surveyed and mapped, and photo-mosaics were created. Reconnaissance inspections were done both outside, and, when possible, inside the vessels. Very limited diagnostic artifact collection for identification and dating purposes included copper sheathing, wood, ceramics, and shipboard equipment.

Among the many bio-physical conclusions derived from this study, a couple stand out. Of the 14 species of corals collected, 3 were not previously known to occur in the Gulf of Mexico. Two new species of stony corals were collected and are currently being described. One of the two new species was found at *Gulfpenn,* in addition to three authigenic hard-bottom locations. It would be very interesting to identify what characteristic of *Gulfpenn* is similar to that of the natural hard-bottom areas that make it amenable to the coral, whether it is related to the shipwreck itself or to the eco-physical regime in which it is situated. Archaeological analyses determined the potential ages, both when built and lost, and the types of the unidentified wooden shipwrecks. While the identity of these shipwrecks could not be determined, they were proven to eligible to the NRHP under Criterion D. What is undeniable is that, without the multidisciplinary objectives and goals developed for the Lophelia II project, it is likely archaeologists would not readily have had the opportunity to investigate these important archaeological sites.

10.2.4 BOEM and Multiple Partnership Research

BOEM archaeologists are considered to be the stewards of archaeological sites and data on the OCS; however, it is not possible for BOEM to conduct large-scale archaeological and other environmental research projects on its own.[6] Therefore, BOEM partners with other federal and state agencies, universities, and not-for-profit institutions to achieve its research goals. One of these projects was the

[6] For example, BOEM does not have a fleet of research vessels, deep-water ROV equipment, or laboratory facilities.

archaeological and biological investigation of what are known as the three Monterrey Shipwrecks.[7]

The Monterrey Shipwrecks were discovered in 2011 during an environmental assessment survey commissioned by Shell Offshore, Inc., at approximately 1330 m water depth and approximately 200 miles off the coast of Texas and Louisiana (GEMS 2012). They are located approximately four miles distance from each other. The seafloor in the area is generally flat and composed of mildly bioturbated muds. Sedimentation rates in the region are very low. In 2012 Monterrey A was chosen as a target for an ROV reconnaissance dive from the R/V *Okeanos Explorer*, NOAA's ship of exploration. All archaeologist participation on the dive was via telepresence.[8] The 1.5- hour-long dive revealed an approximately 200-year-old copper-clad sailing vessel with a high-density of artifacts including ceramics, glass, rigging accoutrements, navigational equipment, anchors, and ordnance (Cruise # Ex 1202 L3).

The excellent preservation of Monterrey A and its likelihood for providing important data relating to seafaring and social conditions in the Gulf of Mexico during the early nineteenth century prompted BOEM archaeologists and other regional scientists to pursue a partnership that would allow an in-depth investigation of the shipwreck. The research partnership included scientists from the federal agencies BOEM, BSEE, United States Geological Survey, NOAA Office of Exploration and Research, NOAA's Office of National Marine Sanctuaries, and NOAA's National Centers for Coastal Ocean Science; Texas A&M—Galveston; Texas A&M—College Station; The University of Rhode Island; The Meadows Center for Water and the Environment at Texas State University; the Texas Historical Commission; Maryland Historical Trust; the American Museum of Natural History; and The Ocean Exploration Trust.

In July 2013, seven of the project archaeologists conducted archaeological investigations at Monterrey A from The Ocean Exploration Trust's R/V *Nautilus*. Field research included a full reconnaissance of the site, ROV-based multibeam bathymetry, high-resolution photo-mosaicing of the site, and high-resolution video inspection of the hull, vessel components, and artifacts. Sixty diagnostic artifacts were collected and are undergoing conservation at Texas A&M—College Station. A small "shovel-test"[9] was completed within the vessel using the ROV suction and tank recovery system.

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[7] The identities of the Monterrey Shipwrecks are unknown. Monterrey refers to the oil field prospect on which they were discovered. They are referred to as Monterrey A, Monterrey B, and Monterrey C because that was the order in which they were ground-truthed and investigated.

[8] Telepresence is real-time high definition audio, video, and computer feeds transmitted by satellite via the Internet II network. Participants at on-shore stations have access to incoming data as if they were on the vessel. Audio and video feeds are also live-streamed to the public via the internet.

[9] An archaeological shovel test is a small excavation, typically one foot in diameter, that is used to determine if further investigation and excavation is warranted at a particular location. The water jet and suction system was used to collect this material in the ROV's storage tanks for screening at the surface.

Project biologists from several agencies and institutions created a biophysical research plan for the cruise and participated via telepresence and directed biological and geological sampling. The goals of the biophysical plan were to describe the biological assemblage in and around the shipwreck and to understand the conditions that influenced the number and distribution of organisms present. Sets of replicate sediment cores were taken adjacent to and approximately 60 m from the shipwreck. Meiofaunal and trace metal analyses were done once the samples were taken ashore. Biological specimens were also collected, including tube-worm remains, two “fudge ripple” anemones collected with the ROV suction system, and a large fly-trap anemone that was recovered attached to the flint-lock mechanism of a musket. Two arrays of various wood coupons were placed adjacent to the shipwreck to study biological recruitment and material degradation.

The team decided that there was enough project time to conduct a short reconnaissance survey of both Monterrey B and Monterrey C in addition to the work at Monterrey A. Monterrey B was identified as a small, unclad sailing vessel with its cargo intact; Monterrey C as a very large, copper clad sailing vessel empty of cargo. The quality of preservation and potential for providing important archaeological data of these two shipwrecks is equal to that of Monterrey A. Both appear to be of the same age as Monterrey A, and one of the primary research goals is to determine if and, if so, why they were sailing together.

The research team was given the opportunity during the summer of 2014 to revisit the three shipwrecks on the R/V *Okeanos Explorer* (Cruise # Ex 1402 L3). The entire scientific program of this cruise was conducted via telepresence. As the large amount of archaeological data was only beginning to be analyzed, the focus of the expedition was a more detailed biological survey and mapping program of the three shipwrecks designed from the reconnaissance survey of the previous year.

During and after the three cruises and ROV investigations of the Monterrey shipwrecks, by working together, the project archaeologists and biologists quickly realized that there were questions of archaeological formation processes, community structure, and ecological succession that could only begin to be addressed through the multidisciplinary expertise of the project participants. Two examples of continuing research are presented below.

10.2.4.1 Species Recruitment and Archaeological Substrate on Monterrey A

As stated previously, biologists typically characterize shipwrecks as hard-bottom structures. Working together, project archaeologists and biologists were able to quantify that different species appeared to colonize different archaeological substrates (Fig. 10.4). Whether this is due to recruitment preference, community competition, the state of ecological succession that was observed during field operations, or random chance is unclear. For example, 21 fly-trap anemones were identified on Monterrey A. In all but one case, they were found attached to large, metal, primarily iron surfaces, including the ship’s guns, the ship stove, rigging elements, and

Fig. 10.4 The sternpost of Monterrey A. The lead sheathing is covering in branching hydroids. A large fly-trap anemone is attached to an iron object attached to the hull of the vessel. (Image courtesy of NOAA 2014: Monterrey Shipwrecks Expedition)

musket hardware. The outlier was attached to the rough broken edge of a large ceramic water jug called a *cantaro*. None were present on glass bottles, lead striping, or copper sheathing. Two possibilities for this are proposed. One is that fly-trap anemones prefer recruitment to rough surfaces in deep water. Recruitment studies on cnidarians in shallow water have shown similar preferences (e.g., Carleton and Sammarco 1987). Another possibility is that fly-trap anemones are able to survive the process of iron corrosion that alters, sometimes rapidly, the surface of iron objects while other species cannot.

The 107 “fudge ripple” anemones on Monterrey A appeared to be less selective. They were found attached to several features and artifacts of varying composition including iron, glass, and wood.

Branching hydroids were frequently observed, and were found primarily on lead sheathing at the bow of the vessel and on a large iron anchor and gun. They were the dominant species colonizing lead (unlike the formation of iron corrosion products, lead oxide forms a stable surface). Hydroids were also the species found in closest proximity to copper sheathing or copper-impregnated wood, raising questions about the resistance of these animals to copper poisoning.

The only other species found on lead surfaces were stoloniferous octocorals. They occupied the draft indicators nailed to the copper sheathing. These octocorals were also the primary colonizers of lead-glazed creamware. They were also identified on iron substrates, the lead surfaces on the stern of the ship, and the glass rim of a bottle amidships. An attempt was made to collect octocoral specimens with recovery of the plates, but the animals did not stay intact during ascent through the water column.

Fig. 10.5 Live vestimentiferan tube worms amidships on Monterrey A. (Image courtesy of NOAA 2014: Monterrey Shipwrecks Expedition)

It is possible that many species that now appear to prefer various metal or ceramic surfaces might have done well on wood surfaces as well, when they were available. It is likely that animals recruited to the wood of the shipwreck shortly after sinking, but disappeared as the perishable wood deteriorated. Still, there are clear habitat preferences, as glass and ceramic objects had very different assemblages than those made of metal (glass objects frequently harbored small populations of serpulid polychaete worms). The apparent preference of fly-trap anemones for iron objects is interesting, particularly given that the limited space available in the deep sea might support opportunistic substrate selection. As described above, this may have to do with recruitment preferences, but it cannot be ruled out that the animals might have been found on wood as well. Archaeological analysis can delineate the process by which the shipwreck has deteriorated over the last 200 years.

10.2.4.2 Chemosynthetic Activity on Monterrey A

Two observations on Monterrey A suggest the presence of at least small areas where chemical conditions support chemosynthetic organisms. Two living vestimentiferan tube worms (*Lamellibrachia* sp.) were located adjacent to a ceramic plate near the stern (and possibly a third along the port side), with a small area nearby covered by what appeared to be a filamentous, white bacterial mat (reminiscent of *Beggiatoa*, which is a commonly occurring sulfide oxidizing bacteria found elsewhere in the Gulf of Mexico) (Fig. 10.5). More bacterial mats were seen around a hole in what appeared to be a container holding a dark substance; a sample of the material was collected for analysis. If the container surrounded by bacterial mats is found to contain gunpowder, that could suggest that the powder provides a source of sulfur and stimulates growth around the hole.

Sulfur-related bacteria are known to occur the Gulf of Mexico, but they are more typically associated with natural gas or brine seeps containing chemicals like hydrogen sulfide and methane. They occupy areas close to anoxic or hypoxic areas but also need oxygen from overlying seawater. The materials on shipwrecks themselves have been demonstrated to give rise to chemosynthetic life. Bienhold et al. (2013) found that wood-boring animals facilitate the development of anoxic zones and anaerobic microbial processes that attract and support sulfate-reducing and cellulolytic bacteria, *Bathymodiolus* and other mussels, the clams *Solemya* and *Acharax*, and siboglinid vestimentiferans.

Two shipwrecks were previously reported to have supported vestimentiferan tube worms. In both cases, the tube worms were identified as *Lamellibrachia* sp. It was assumed that both shipwrecks obtained larval recruitment from relatively nearby volcanic venting or seeps. Dando et al. (1992) recovered two empty tubes from the wreck of *Francois Vieljeux*, a container ship that sank in 1979 off the coast of Spain in 1660 m of water. The water was warm (10 °C) and had high salinity. The organisms were recovered from the interior of the vessel using a large grab. They were apparently growing in sacks of beans sitting atop plastic wrapped bales of sisal twine. The beans were black and pulpy, indicating sulfide reduction. The tubes were very long, indicating a growth rate of 9.5–12.7 cm per year, similar to that of vent species, but at a much higher rate than other *Lamellibrachia* sp. found at seeps and at the second shipwreck.

The second shipwreck reported to support vestimentiferan tube worms was the *SS Persia*, a passenger liner that was sunk by a German U-boat off the coast of Crete in 1915 (Hughes and Crawford 2006). Researchers recovered hundreds of tubes, including those that contained animals, from the deep interior of the ship at 3000 m. The organisms were also recovered from the interior of the vessel using a large grab during salvage operations attempting to access the bullion room. They were growing in a substrate composed of bales of primarily newspaper and some other paper products. Some tubes were over a meter in length.

The small “shovel test” on Monterey A in the aft portion of the vessel indicates that there is at least a foot of woody pulp within the wreck that is most likely composed of degraded decking and other structural material. We did not determine the full depth of this material. It appears that the copper sheathing rendered a large portion of this material inhospitable to wood-boring molluscs.

This evidence, combined with the data presented in Beinhold et al. (2013) and others (e.g., Perez et al. 2002) indicates that it may be the degradation of the insoluble fiber (cellulose, hemicellulose, and lignin) of the wood/newspaper/beans that is providing the substrate that is being anaerobically digested into methane and subsequently into sulfide rendered bioavailable to chemosynthetic symbiotic species. Newspaper is nearly fully comprised of cellulose and lignin. Wood cells are composed of insoluble fiber; therefore nearly all of the original wood mass unaffected by borers remained available for degradation. The insoluble fiber content of beans is variable but is shown to range from 11.6% (chickpeas) to 20.4% (kidney beans) (Perez-Hidalgo et al. 1997). The fact that both the beans and the wood from Monterey A were both pulpy suggests that anaerobic degradation is taking place. The material is essentially composting.

This supports previous conclusions that the shipwrecks and/or their cargo must go through an initial process of microbial degradation before chemosynthetic recruitment can begin. The insoluble fiber must first be broken down anaerobically into carbon dioxide, methane, and water. Freely available chemosynthetic symbionts and the larvae of vestimentiferans and the other macrofauna harboring chemoautotrophs can then recruit, either consecutively or perhaps concurrently.

The rate at which this process happens is unclear from the literature,[10] but it does appear dependent on temperature, substrate, prokaryotic and *Lamellibrachia* species, and time. The tube worms in *Francois Vieljeux* grew extremely fast, but the water was very warm (over 10 °C). They were inside the vessel; however, it appears that water could exchange relatively easily between the hold and outside the shipwreck. The lack of living tube worms coupled with the low insoluble fiber content of the beans may indicate that the availability of methane decreased on the collected bale below what is required to sustain life. The tube worms on the *SS Persia* grew at the expected rate for *Lamellibrachia* sp. over a 90-year period in the interior of the vessel where there would be very little water exchange. Monterey A is open to the environment, though current activity appears minimal. The shipwreck is twice the age of the *SS Persia*, but the living and remnant tubes of dead animals appear small, so either microbial degradation rates are slow, or recruitment is periodic. Unfortunately, only short observation papers were prepared on the tube worms of *Francois Vieljeux* and *SS Persia* tube worms.

As stated above, both Dando et al. (1992) and Hughes and Crawford (2006) indicate a vent or seep from which recruitment likely derived. Bright and Lallier (2010) indicate that vestimentiferan larvae can remain planktonic for approximately 45 days. The widespread nature of natural gas seeps in the Gulf of Mexico make it likely that there is a methane seep with a 45-day ambient drift of Monterey A, and that there could also be periodic recruitment controlled by Loop Current eddies.

During previous investigations of *Anona*, vestimentiferan tube worms were observed growing within the shipwreck's hull at two locations, at the bow and the stern. Initial videos from 2004 and 2007 suggest these were living colonies. During the most recent investigations at *Anona* in 2014, the health of the tube-worm colonies could not be determined. Likewise, the data is incomplete as to whether the tubeworm colonies developed as a result of the deterioration of *Anona*'s cargo of potatoes or because of the fuel that remains inside the hull. The presence of tubeworms at the *Anona* site, however, may lend support to the hypothesis that chemosynthetic activity associated with shipwrecked perishable cargoes, fuel stores, and wooden infrastructure is more common than was previously supposed. Now that archaeological programs researching deep water shipwrecks are becoming increasingly multidisciplinary, future studies can collect the much-needed additional data to prove or disprove this hypothesis.

[10] See Palacios et al. (2006) for an example.

10.3 Conclusion

The above described research projects funded and/or supported by BOEM show the evolution of multidisciplinary archaeological and biological research on submerged archaeological sites on the Gulf of Mexico OCS. The destructive nature of archaeology does at times result in the removal of biological organisms from artifact remains as part of conservation and recording. Today, as a result of the UNESCO Treaty for the Protection of Underwater Heritage, the focus has shifted to more in situ study than recovery, lessening the impact of archaeological practices on the ecosystems associated with shipwreck sites. Although the United States has not ratified the UNESCO Treaty, BOEM and other federal agencies tasked with protecting the natural and cultural aspects of submerged archaeological resources follow the guidelines with the treaty.

Several decades of required environmental, archaeological, and hazard surveys in advance of oil and gas operations in the Gulf of Mexico have allowed archaeologists and other scientists to develop a detailed understanding of the deep-water socio-cultural, ecological, and physical landscape. Within this landscape, BOEM scientists and its outside research partners have developed multidisciplinary research programs to investigate landscape attributes, such as archaeological sites and biological organisms, and their relationships with one another. These research programs have grown in complexity over the last two decades.

The first large-scale multidisciplinary research project, *Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico* (2004–2007), surveyed, mapped, and analyzed seven World War II era deep-water shipwrecks. In addition to traditional archaeological data collected at each site, a biological reconnaissance survey was completed assessing and comparing the reef effects created by the shipwrecks, and sediment core analysis determined the fouling effects the shipwrecks may have on the surrounding environment. The "*Lophelia II*" project (2008–2016) expanded on this type of multidisciplinary research by controlling for presence of a particular coral species instead of only age and primary material component of the shipwrecks. This allowed for the reef effects of circa 1870s–1910s wooden sailing vessels[11] and World War II era steel vessels to be compared. The project also allowed for the comparison of the reef effects of shipwrecks to modern commercial infrastructure (oil and gas platforms) and natural authigenic hard-bottom areas. This allows archaeologists and biologists to begin to study the unique role that shipwrecks play in the formation of benthic and reef community structure in the Gulf of Mexico—information that can only help promote the preservation of both shipwrecks and biological communities.

The Monterrey Shipwrecks project was managed by a large multidisciplinary team of both offshore and onshore scientists. Telepresence during the entirety of all three cruises[12] allowed for unlimited participation by shore-based scientists. In

[11] That the wooden sailing vessels age ranges clustered into only a few decades was luck. The ages of the vessels had not been previously determined before the commencement of this project.

[12] 2012—R/V *Okeanos Explorer*; 2013—R/V *Nautilus*; and 2014—R/V *Okeanos Explorer*.

addition to traditional ROV-based archaeological and biological data collection, project scientists worked together to form true multidisciplinary hypotheses, such as species recruitment and community structure relative to archaeological substrate and chemosynthetic recruitment and consumption of shipwreck materials, that can only be addressed within a multidisciplinary context.

It is clear that as technology improves and costs decline, deep-water archaeological sites on the OCS may become easier to access, allowing for increased opportunities to incorporate these sites into research programs, including those funded and/or supported by BOEM and other federal agencies. These projects are, however, still very expensive. Pursuance of this research has proven successful through robust multidisciplinary projects where the scope encompasses the archaeological, ecological, and physical sciences for a more holistic approach.

References

Ballard, R. D. (Ed.). (2008). *Archaeological oceanography*. Princeton: Princeton University Press.

Bass, G. (1967). Cape Gelidonya: A Bronze Age Shipwreck. *Transactions of the American Philosophical Society*, Vol. 57, Part 8.

Beinhold, C., Ristova, P. P., Wenzhöfer, F., Dittmar, T., & Boetius, A. (2013). How Deep-Sea wood falls sustain Chemosynthetic life. *PLoS One, 8*(1), e53590. https://doi.org/10.1371/journal.pone.0053590.

Bright, M., & Lallier, F. H. (2010). The biology of Vestimentiferan tubeworms. *Oceanography and Marine Biology, 48*, 213–266.

Broadwater, J. (2012). *USS monitor: A historic ship completes its final voyage*. College Station: Texas A&M University Press.

Brooks, J. M., Fisher, C., Cordes, E., Baums, I., Barnard, B., Church, R., Etnoyer, P., German, C., Goehring, E., MacDonald, I., Roberts, H., Shank, T., Warren, D., Welsh, S., Wolff, G., & Weaver, D. (2016). *Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard-Bottom Habitats with Emphasis on Coral Communities: Reefs, Rigs, and Wrecks—"Lophelia II" Final Report*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2016–021.

Carleton, J. H., & Sammarco, P. W. (1987). Effects of substratum irregularity on success of coral settlement: Quantification by comparative geomorphological techniques. *Bulletin of Marine Science, 40*(1), 85–98.

Church, R., Warren, D., Cullimore, R., Johnston, L., Schroeder, W., Patterson, W., Shirley, T., Kilgour, M., Morris, N., & Moore, J. (2007). *Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico: Artificial Reef Effect in Deep Water*. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, OCS Study MMS 2007–015.

Dando, P. R., Southward, A. J., Southward, E. C., Dixon, D. R., Crawford, A., & Crawford, M. (1992). Shipwrecked tube worms. *Nature, 356*, 667.

Geoscience Earth & Marine Services, Inc. (GEMS). (2012). *Geologic, Stratigraphic, and Archaeological Assessment, Keathley Canyon Area, Gulf of Mexico*. Project No. 0211–1881.

Gregory, D. (2016). Degradation of wood. In M. E. Keith (Ed.), *Site formation processes of submerged shipwrecks*. Gainesville: University Press of Florida.

Hughes, D. J., & Crawford, M. (2006). A new record of the vestimentiferan Lamellibrachia sp. (Polychaeta: Siboglinidae) from a deep shipwreck in the eastern Mediterranean. *Marine Biodiversity Records, 1*(21), 1–3.

MacLeod, I. D. (2016). Corrosion products and site formation processes. In M. E. Keith (Ed.), *Site formation processes of submerged shipwrecks*. Gainesville: University Press of Florida.

McManamon, J. M. (2016). *Caligula's barges and the renaissance origins of nautical archaeology under water*. College Station: Texas A&M University Press.

Muckelroy, K. (1978). *Maritime archaeology*. London: Cambridge University Press.

Palacios, C., Zbinden, M., Baco, A. R., Truede, T., Smith, C. R., Gaill, F., Lebaron, P., & Boetius, A. (2006). Microbial ecology of deep-sea sunken wood: Quantitative measurements of bacterial biomass and cellulolytic activities. *Cahiers de Biologie Marine, 47*, 415–420.

Perez, J., Munoz-Dorado, J., de la Rubia, T., & Martinez, J. (2002). Biodegradation and biological treatments of cellulose, hemicellulose and lignin: An overview. *International Microbiology, 5*, 53–63.

Perez-Hidalgo, M., Guerra-Hernandez, E., & Garcia-Villanova, B. (1997). Determination of insoluble dietary fiber compounds: Cellulose, hemicellulose and lignin in legumes. *Ars Pharmaceutica, 38*(4), 357–364.

Robinson, D., Goddio, F., & Fabre, D. (2017). Environment and Agency in the Formation of the eastern ship graveyard in the Central Basin at Thonis-Heracleion, Egypt. In A. Caporaso (Ed.), *Formation processes of maritime archaeological landscapes*. Cham: Springer.

Sanchez-Porro, C., Kaur, B., Mann, H., & Ventosa, A. (2010). Halmonas Titanicae Sp. Nov., a Halophilic bacterium isolated for the RMS Titanic. *International Journal of Systematic and Evolutionary Microbiology, 60*(12), 2768–2774.

Ward, I. A. K., Larcombe, P., & Veth, P. (1999). A new processed-based model for wreck site formation. *Journal of Archaeological Science, 26*(5), 561–570.

Part III
Historical Archaeology and the Anthropocene

Chapter 11
Archaeology and the Anthropocene in the Study of Settler Australia

Susan Lawrence and Peter Davies

Abstract Environmental archaeology of settler colonialism in Australia is well placed to make an important contribution to our understanding of the Anthropocene. Environmental data provide perspectives on settler-driven change and places it in the long-term context of anthropogenic change that began with the arrival of Aboriginal people some 65,000 years ago. Historical archaeology is uniquely placed to interpret this record. It has the capacity to integrate scientific data about the environment with humanities-based understandings about culture and human agency. It also has the capacity to interrogate multi-scalar data about human activity ranging from the site-specific to the global and extending from the present into deep time. This chapter reviews the work of archaeologists using environmental data and the work of natural scientists producing data about environmental change over the past two centuries. Included in this is work on soil erosion and sedimentation as well as floral and faunal research. It is argued that research which more closely integrates archaeological approaches with environmental science has considerable potential to provide insights into anthropogenic environmental change and into human adaptation to the changes caused.

The environmental archaeology of settler Australia has the potential to offer valuable insight into the Anthropocene, one of the greatest transformations in global history. European colonisation in the form of British settlement began on the east coast of Australia in 1788, marking a radical disruption to 65,000 years of sophisticated but subtle human management of the environment. British colonisation coincided with the invention of steam power and the beginnings of the Industrial Revolution. It was a pivotal moment in planetary history and it made the Australian continent a laboratory for demonstrating the speed and extent of anthropogenic environmental change that was now possible.

Anthropogenic environmental change in Australia is not new. It began when Aboriginal people started using fire as their primary tool for managing resources. Regular burning manipulated plant and animal populations to increase the accessibility, reliability and sustainability of food supplies. Aboriginal stewardship of the

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land had enabled them to survive profound climatic change through the Last Glacial Maximum and the onset of the Holocene. It created the mosaic of grasslands, lightly timbered 'parks' and dense forest that was observed by the first European settlers. What is new in the past 200 years is the nature and scale of environmental change initiated by the plants, animals and technologies brought by the Europeans. In the century after the European arrival the ecology of the entire continent was reworked by the disruption of fire regimes and the destruction of Aboriginal cultures that had sustained them, the introduction of plough agriculture, the wholesale clearance of forests and the spread of exotic plant and animal species into every ecological zone.

The new settlers arrived with a suite of exotic plants and animals centred on the domesticated species that had spread throughout the Old World following the origins of agriculture. They brought sheep and cattle that overgrazed the native grasses and compressed the soil with their hard hooves. The settlers replanted the land with their own pasture crops and with new grasses that they needed for their own consumption. The seed and animal fodder carried unwanted plants that spread rapidly as invasive weeds, as did the animals and insects that had stowed away on the ships. Some of the plants and animals brought by settlers flourished too well in a new land without familiar predators, and the predators introduced by settlers compounded the problem. The introduction of new grasses, the animals that grazed on them and the plant and animal pests that accompanied them was only the most obvious change. Forests and woodlands were cleared to make way for crops and grazing. Tree clearance and ploughing exposed the soil and caused erosion as the soil disappeared. When soil washed into streams it reshaped rivers and wetlands and changed the way the river systems worked.

Along with a new ecology, British colonisation also brought a new and profoundly different way of managing the land. Aboriginal intervention in the environment focused on the plants and animals that lived on the surface of the ground. Excavations were shallow and localised and of low impact. Aboriginal people dug into the ground to plant and harvest root crops, they worked shallow stone quarries for raw materials and they moved stones to create weirs, fish traps and ceremonial places. The British cut into the soil with ploughs; used iron saws and axes to remove forests and expose the soil to the wind and rain; and used picks, shovels and explosives to dig mines and to build roads, railways and dams. By the late nineteenth century steam power made these processes more efficient and even larger in scale, while mining and manufacturing began introducing contaminants into the ground and water. The new technologies brought by settlers enabled them to mould and shape the land itself, sometimes in ways that were desired and sometimes in ways that were unexpected.

So where does archaeology come in? Archaeology, and particularly historical archaeology, is uniquely situated to explore the dynamics and consequences of the changes that began to unfold. So far, historical geography and environmental history have led the way in telling the story of recent environmental change in Australia, but the story is largely drawn from documentary sources and isolated from the deep time that precedes it. Environmental data from disciplines such as ecology, palynology and geomorphology have yet to be fully integrated into the human narrative revealed in the documents. As a discipline, archaeology provides the combination of investigative and interpretive skills that enable it to address the nature of the evidence and the changes taking place. Archaeologists routinely integrate data and explanation from the natural sciences with understandings of human culture and behaviour drawn from the humanities, a skill set that is critical for analysing anthropogenic environmental change. Archaeologists also routinely integrate evidence from fine-grained excavations of single sites within the broader context of cultural landscapes and global networks. Finally, archaeology brings the temporal perspective necessary to place recent events in the context of geological time. It is archaeology that has established the date of earliest human arrival on the Australian continent and that has begun to write the history of the millennia that followed. It is historical archaeology, working with documentary as well as material sources, that can integrate the multiple lines of evidence needed to understand what has happened to the environment in the 200 years since European arrival.

A critical engagement across the humanities and natural sciences enables debate to move beyond nature/culture dichotomies and environmental determinism. It facilitates the acknowledgement of the independent trajectories of natural processes and the ways in which social action is entangled in those processes. It is useful here to extend the concept of entanglement (Hodder 2012; Thomas 1991) from objects and sets of objects to ecosystems and landscapes. People intervene in natural systems in particular and deliberate ways, breeding species to enhance specific traits and moving them from one location to another, cutting down trees and building dams. The natural processes that guide how species evolve and interact and that determine how soil forms and erosion takes place incorporate human action as one of many influences and provide their own momentum that carries change in novel directions. Humans, as biological and cultural agents, operate within the systems they seek to influence and find that their actions are responses to circumstances that are the result of earlier actions. Individual plant and animal species, ecosystems and landforms are all the product of the intersection of action and process. Recognising the consequences of human action can provide explanation for change and break down the illusion of separation between people and planet. It also re-establishes choice as a powerful determinant of change. Humans do have agency and circumstances are contingent on historical, social and geographic context so that it is possible to have hope as well as grief when confronting the future (Head 2016).

In this chapter we review the work done by historical archaeologists using environmental approaches and outline areas of future potential. In particular, we draw attention to the rich literature produced by environmental scientists that documents post-European changes to the Australian environment in the areas of flora and fauna, soil erosion and sedimentation. We argue that the most productive path for future research on the Anthropocene is in building relationships between historical archaeology, history and environmental science. Scientific data can reveal the scale of change in unexpected ways while historical and archaeological approaches can provide insight into human agency and social context. One of the strengths of environmental science is its capacity to measure the nature of change and to compare the rate of change over the past 200 years with long-term changes through the

Pleistocene and Holocene. Environmental scientists have recognised that human action is one of the processes informing change and they are documenting ways in which human action has been incorporated into natural systems through assessing impact and resilience in earth processes (e.g. Brown et al. 2017). One of the strengths of humanities scholarship is its ability to address the human causes of action, foregrounding agency, historical contingency and the multiplicity of potential actions that are available (Head 2014). The humanities emphasise the creativity, diversity and resilience of human societies. Trajectories that seem inevitable at one point in history or one place on the globe will have entirely different outcomes at another place or time.

In this discussion we adopt a broad definition of the environment that encompasses earth systems and hydrology as well as the biological systems that are the more conventional domain of environmental archaeology (e.g. Hardesty 2009; Mrozowski 2010). One of the key insights of recent Anthropocene research is the extent to which humans have acted upon planetary stratigraphic records (Brown et al. 2017; Edgeworth 2014b; Lawrence et al. 2016; Macklin et al. 2014; Rohe 1983; Sutter 2015; Walter and Merritts 2008). Distinct and widespread depositional layers that are the consequence of human activities such as farming and mining have now been identified in many parts of the world. The study of water and its intersections with human cultural and action has likewise received increasing attention in recent years. Historians, anthropologists and archaeologists have studied the physical infrastructure to manage water, the cultural meanings of water and how understandings of the movement and behaviour of water can shape archaeological explanation (Edgeworth 2011; Strang 2004; White 1995). The environment in which social action is embedded includes both living and non-living systems and we argue that the potential of environmental archaeology lies in its capacity to study the interconnections among human systems, ecological systems of plants and animals and earth systems of sediment and water.

It is important to note that in the discussion that follows we have chosen to refer to ‘British’ colonisation and settlement. The modern nation of Australia was initiated and politically controlled by the British government as a colonial outpost beginning with the arrival of convicts and their guards at Sydney Cove in 1788. While the government was British, the settlers themselves were ethnically diverse and included migrants from England, Scotland and Wales and a particularly strong Irish Catholic contingent. The gold rushes of the 1850s brought further diversity with people arriving from many parts of Europe, North America and Asia, including many Chinese. In addition there were German settlers in South Australia, ‘Afghan’ cameleers in Central Australia who came from modern-day Pakistan, India and Afghanistan, Pacific Islanders in Queensland and Indonesian and Japanese fishers on Australia’s northern coastline. All participated in transforming the Australian environment through their labour in diverse areas including agriculture, horticulture and pastoralism and in the mining, timber and fishing industries.

11.1 Historical Archaeology and the Anthropocene

The Anthropocene is a term coined by Paul Crutzen and Eugene Stoermer (2000) to describe the period in the Earth's history when humanity has become the driving force behind significant planet-wide change in natural systems. Initially it described extreme changes in the chemistry of the Earth's atmosphere and oceans driven largely by the burning of fossil fuels. The term was rapidly expanded, however, to include a suite of anthropogenic changes such as plant and animal extinctions, urbanisation and human population growth and changes to the Earth's surface through resource extraction. The term has been embraced by many disciplines in the sciences and humanities and is now used as a tool for thinking about domains that are not always readily linked as biologists, geologists, oceanographers and others look collectively at the evidence and causes of change on a planet-wide scale (Edgeworth 2014a). In the humanities, scholars including historians, sociologists and literary critics have used the Anthropocene as a heuristic device for 'thinking like a planet' (Robin 2013), using new scales of time and space to imagine possible futures. They have also firmly interceded on behalf of the 'anth' in Anthropocene, providing a humanistic perspective that insists on human agency and also on the importance of human responsibility for choice and action (Chakrabarty 2009; Head 2014).

The beginning of the Anthropocene has always been one of its most contentious characteristics, and one critical to its formal adoption as part of the Geologic Time Scale. Arguments have been made for dates ranging from the Neolithic, based on the plant and animal changes triggered by domestication and the beginnings of farming (Erlandson and Braje 2014; Head 2014) to the post-WWII period and the global marker provided by the detonation of nuclear devices (Lewis and Maslin 2015). Not surprisingly, archaeologists have been closely associated with arguments in favour of early origins (e.g. Braje 2016) and the importance of understanding long-term human-environment intersections. Archaeologists of the recent past have also critically engaged with more recent origin points, offering stratigraphic evidence and multiple perspectives on human-object interactions grounded in material culture studies (see papers in *Journal of Contemporary Archaeology* 1(1) 2014). Among the stratigraphic markers suggested for later Anthropocene origins are new anthropogenic materials such as concrete, aluminium and plastic (Waters et al. 2016). These materials became globally distributed in the nineteenth century and their production and dissemination increased dramatically following the Second World War, alongside other markers of the Great Acceleration (Waters et al. 2016).

Two Anthropocene periods are of particular relevance for a historical archaeology that defines itself as the archaeology of the modern world and dates its own origins to the incorporation of Old and New Worlds in a single world system. The first period is that suggested by Crutzen himself: the Industrial Revolution, when people began burning fossil fuels in large quantities to power machines (Crutzen and Steffen 2003). The second period is the sixteenth century when the European colonisation of the New World began (Lewis and Maslin 2015; Lightfoot et al.

2013). Archaeological evidence from California is used to argue that the Industrial Revolution should be seen as part of a continuum rather than as a distinct break from what had gone before (Lightfoot et al. 2013). Lightfoot and his colleagues point specifically to the radical transformations of the Californian environment driven by the 200 years of Spanish colonisation that preceded the nineteenth-century gold rush and to the globally connected networks of which that colonisation was a part. More specifically, geographers have used isotopic markers in ice cores to argue for an 'Orbis' date of 1610 as a starting point for the Anthropocene. Lewis and Maslin (Lewis and Maslin 2015) argue that a sudden decline in global carbon dioxide emissions between 1570 and 1620 was caused by a rapid re-forestation of land in the New World. They argue that in the sixteenth century the collapse of indigenous populations in the New World caused by pandemic disease triggered the abandonment of agricultural land which was then reclaimed by forests. The increase in forest cover resulted in more sequestering of carbon and thus the decline in atmospheric CO^2.

It is the former date which is of greatest relevance here because the invention of steam power is co-incident with the establishment of the Second British Empire and the settler colonies of Australia, Canada, South Africa and New Zealand. The British colonisation of Australia is a product of the industrial age (Jack 1979). Coal mines and iron smelters were among the first manifestations of industrialisation (Jack and Cremin 1994), while railways and paddle steamers penetrated inland less than 50 years after the first permanent settlement in most colonies and within the first 100 years of settlement in New South Wales and Tasmania. The city of Darwin was established explicitly in order to support inter-continental telegraph communication. Physical evidence of the industrialised transformation of the environment is thus inextricably linked with British colonisation.

11.2 Historical Archaeology and the Australian Environment

Understanding how settler cultures have interacted with the Australian environment has been a long-standing theme in historical archaeology in Australia. At the broadest scale it has informed the explanations offered for the type and distribution of sites occupied as settlers struggled to impose Old World systems on the environment. At the smallest scale, environmental evidence has revealed intimate details of how local environments have been altered by the clearing of native vegetation and the planting of gardens. In between those extremes are the numerous studies of resource extraction activities in which the environment has been the backdrop that has structured settler colonisation. Despite the centrality of the environment as a participant in the British colonisation of Australia, an explicit focus on the environment has been lacking in historical archaeology here as it has been elsewhere, echoing a trend that Hardesty has identified in the United States, where environmental explanations in historical archaeology have similarly been marginalised (Hardesty 2009:67). Studies that have explored how settler activities shaped local or regional landscapes have tended to privilege social and historical factors over environmental ones and there has been little systematic investigation of the links between the environment and colonisation. Archaeologists have been primarily concerned with documenting places of settlement and the structures and objects found there and have been less concerned with exploring the relationship among the places and objects and the natural systems in which they are embedded.

The most common approach to the environment in Australian historical archaeology has been that of adaptation. The Australian continent, with its entirely unfamiliar plants and animals and its reversed seasons, has been a source of wonder and bewilderment from the time of the earliest British settlement. Adaptation to new environments has thus been an important and enduring theme for archaeological research. It provided a key motivator in one of the first theoretical models developed to provide overarching structure and explanation for studying Australian sites. In the Swiss Family Robinson model (Birmingham and Jeans 1983) the distribution of sites and the ultimate success or failure of the enterprise was interpreted as a process of experimentation to determine what imported technology would work and what would not in Australian conditions. This approach influenced a range of later studies, particularly of industrial sites. Researchers have investigated how the availability of water influenced the success of water-powered flour mills (Connah 1996; Pearson 1997), developments in the pastoral industry to accommodate the need to wash and transport wool (Cummins 1989; Pearson 1984) and the emergence of distinctive Australian industries such as eucalyptus distilling that were an explicit response to unique resources (Pearson 1993).

The spatial patterning of resource exploitation can be seen as a subset of this approach to environmental adaptation. As settlers located resources and developed extractive techniques to maximise profit, the spatial distribution of sites closely matched the distribution of resources. The natural environment determined the resulting mosaic of human use as people responded to attributes such as the location of timber species (Davies 2005), appropriate coastal locations for hunting and processing whales (Gibbs 1998) and deposits of limestone that were easily accessible for coastal transport (Harrington 1996). The spread of settlers across the Outback was determined by access to water for their sheep and cattle. Settlers appropriated Aboriginal waterholes along tracks like the Canning Stock Route in Western Australia (Grimwade 1999) and constructed infrastructure including dams and artesian bores to obtain water in western Queensland (Godwin and L'Oeste-Brown 2012).

Writing a decade after Birmingham and Jeans (1983), Egloff (1994) was the first to explicitly foreground the environment itself as a subject of study. Challenging the colonial frontier paradigm embodied in the Swiss Family Robinson model, Egloff argued for the need for historical archaeologists to be more attentive to relations between settlers and Aboriginal people and also to the 'environmental conditions that followed on from the encounter of indigenous people and places with minds and technologies from the European continent' (1994:4). Egloff pointed to the 'despoliation' that followed white settlement and the impossibility of understanding present conditions without reference to changes over the past 200 years. As a means of developing this approach Egloff specifically urged archaeologists to engage more closely with the dynamic field of environmental history then beginning to emerge in Australia.

Environmental history and historical archaeology in Australia each owe a significant intellectual debt to historical geography. The latter discipline emerged strongly in the years after the Second World War with an emphasis on land utilisation in the context of national development (e.g., Wadham et al. 1950). Meinig's (1962) work on the South Australian wheat belt, Hancock's (1972) work on the Monaro in NSW, Buxton's (1967) on the Riverina and Williams (1974) on the Mallee were pioneering studies of post-1788 human interactions with the natural environment at a regional scale. Joseph Powell continued this momentum with spatial and economic analyses of land settlement, deforestation and water utilisation within the context of resource management (Powell 1970, 1976, 1989, 1996), while Wright (1989) repositioned the notion of public interest within a spatial, political and historical framework. Few of these studies did more than touch on issues of Aboriginal engagement with the environment. More recently, however, Gammage's (2011) study of Indigenous burning regimes across Australia identifies cultural landscapes that were not only created to manipulate plant and animal resources but which were, inadvertently, useful to European settlers as well.

Environmental history has continued to gain strength in the intervening years but has lacked a sense of the spatial dimensions of change provided by its earlier association with geography. Over the same period historical archaeology has not engaged as consistently with environmental approaches as it has with Aboriginal post-contact archaeology, in which there has been sophisticated and sustained interest (e.g., Birmingham 2000; Fowler et al. 2014; Harrison 2004; Lydon 2009; Paterson 2008; Russell 2004). Research on the environment has been ad hoc and what Hardesty (2009:68) identifies as a 'biologically-oriented historical archaeology' has been slow to develop. However, there are an increasing number of studies that are showing that in Australia as elsewhere environmental data can contribute to better understandings of the modern world and to its characteristic cultural processes of colonisation, urbanisation and industrialisation (Mrozowski 2006).

Sources of evidence include faunal remains, landforms, botanical remains and landscapes. Faunal studies in particular have become much more common with work on assemblages from urban sites (Colley 2006; Simons and Maitri 2006; Guiry et al. 2014; Howell-Muers 2000), rural sites (Blake 2010; Colley 2005; Gibbs 2005; Lawrence and Tucker 2002) and shipwreck cargoes (Guiry et al. 2015), shedding greater light on settler diet and food procurement strategies. Faunal analysis of tightly dated archaeological assemblages has also enabled researchers to establish dates for the inadvertent arrival of pest species in Australia (Davies and Garvey 2013). Studies of landforms are not numerous, but there is some research that investigates how human activity has remodelled the Earth's surface. Examples include the use of landfill to reshape harbours (McLoughlin 2000), the accidental accretion of land following harbour works (Duncan 2007) and large-scale landscape change as a result of gold mining (Lawrence et al. 2016; McGowan 2001).

Published research making use of palynological, botanical and etymological evidence from soils and cess-pit deposits remains unusual despite important early contributions in this area (Koppi et al. 1985; Higginbotham et al. 1988). A notable exception is work carried out on commercially excavated sites in Sydney, where the analysis of pollen (Macphail 1999; Macphail and Casey 2008) and soil (Lawrie 1999) has yielded critical insight into the how the first convict settlers modified their environments. Palynological evidence has demonstrated the early establishment of vegetable gardens and orchards and the spread of exotic weeds. The analysis of soils has contributed to a broader understanding of site-formation processes, past landscapes and human activity through the identification of former shorelines and human modification through the burning of native timber as fuel and the addition of organic matter, including human waste, to gardens. Other studies of gardens making use of botanical evidence are the work of Maitri (Atkinson 2001) on a rural selector's garden in East Gippsland, Victoria and recent work on the 1880s gardens adjacent to the Royal Exhibition Building in Melbourne (Major et al. 2017).

There have been a number of studies of gardens that have drawn on landscape design features such as paths and the layout of garden beds. This includes the public and domestic gardens created by the early colonial governors and their families in Sydney (Casey 2006), Chinese market gardens (Jack et al. 1984; McGowan 2005), settler gardens in the Adelaide Hills (Piddock et al. 2009) and contemporary urban back yards (Brown 2010a). Understandings of cultural landscapes that have their origins in the work of Carl Sauer (1925) and W.G. Hoskins (1965) have been influential in most of these garden studies. This work has also been influential in the many studies that have looked at the relationship of sites and landscapes at a regional scale (e.g., Burke 1999; Burke et al. 2010; Casella 2006; Jeans 1984; Mate 2010; Mayne and Murray 2001; Winston-Gregson 1984; Young 1985). Whether in rural or urban contexts, landscape studies have investigated elements of style and the spatial patterning of built structures such as buildings, roads and fences as evidence of the influence of culture rather than as evidence of modification of the pre-European environment.

Work in the Adelaide Hills (Smith et al. 2006) has been unusual in Australia for its explicitly processual approach to landscape, drawing inspiration from cultural ecology and the work of Lewis Binford (1982), Julian Steward (1955) and Gordon Willey (1953). The Flinders University team used notions of action spaces, search spaces and awareness spaces (Anschuetz et al. 2001) to develop an integrated approach to recording and interpreting a range of sites associated with activities such as domestic use, gardens, agricultural and horticultural production, extractive industries, water management, transport routes and cemeteries. The large-scale study that resulted covered an area more than 90 kilometres in length and included over 900 sites. The researchers argued that the region is 'one of the best preserved historic landscapes representing the era of eighteenth and nineteenth century European global expansion and colonization in the world' (Smith and Pate 2006:ix).

Despite Egloff's earlier plea to acknowledge environmental change, studies such as the Adelaide Hills project and others (e.g., Lawrence and Davies 2012) continued to be dominated by an interest in settler adaptation to the Australian environment. It was not until 2013 that Paterson (2013) again identified anthropogenic environmental change as a subject for historical archaeological enquiry. In particular Paterson is interested in the long-term indigenous land management practices such as fire-stick farming that preceded settler colonisation. He points to the role this knowledge had in shaping colonial encounters in areas such as the pastoral industry and the continued importance of traditional knowledge for contemporary land management practices. Both Egloff and Paterson have situated settler-driven change within a longer-term continuum of anthropogenic environmental change on the Australian continent. This is significant because it raises the potential for identifying similarities as well as differences in human-environment interactions across the contact period. Human modification of the environment after 1788 was profoundly different but it was not new.

11.3 Ecological History: Perspectives on Settler Colonisation from the Natural Sciences

Archaeological studies start with human action set against an environmental background. Scientific studies start with environmental change over long periods and may or may not search for evidence of human involvement. There is a large body of literature by scientists investigating the long-term environmental record in Australia including the Last Glacial Maximum and the transition to the Holocene. The uppermost layers in sediment cores and pollen sequences contain abundant data about the impact of British colonisation on vegetation, fire regimes, soil erosion and sedimentation. In recent years there has been a burgeoning interest among natural scientists in studying recent anthropogenic change and historical ecology (Clark 1990; Bowman 2002; Dodson and Mooney 2002; Witt 2002). Greater familiarity with this literature will enable archaeologists to better engage with environmental scientists so that our skills can be combined to address some of the fundamental questions about how and why anthropogenic change in the last 200 years has unfolded.

There are several lines of evidence that document changes in vegetation since British settlement. Coring of sediments from lakes and wetlands provides evidence of pollen sequences, charcoal, diatoms and stable isotopes, all of which record the clearing of forests and the arrival of exotic species. This is illustrated in work in the tropical rainforest inland from Townsville in north Queensland (Haberle et al. 2006). Coring of Lake Euramoo has enabled scientists to study local environmental change over the past 700 years. Upper layers of the core demonstrated significant change coincident with the arrival of Europeans in the 1880s. The diversity of species evident in the pollen record decreased, there was an increase in charcoal which reflected an increase in burning as settlers used fire to clear the rainforest and changes in diatom ratios indicate changes in aquatic pH levels that triggered changes in algal and insect communities. The authors note that even though the region has been protected in parks since the 1950s there has been no observable return to pre-European conditions.

The tropical rainforest was not the only region where there is evidence for an increase in fire use with European settlement. Pollen cores from other regions record a similar pattern, including the temperate rain forests of East Gippsland, Victoria (Gell et al. 1993); the Fleurieu Peninsula south of Adelaide, South Australia (Bickford and Gell 2005); and in the Hawkesbury-Nepean valley north of Sydney, NSW (Johnson 2000). In all these areas altered fire regimes resulted in changes to the vegetation such as an increase in grasses as understorey and an increase of *acacia* (wattle) which regenerates quickly on fired land. As settlers burnt the wetlands in South Australia, *leptospermum* (tea tree) colonised the areas that dried out. In contrast, pollen cores on the south coast of NSW suggest that fire frequency decreased after British settlers arrived (Dodson et al. 1993) but this too brought changes to vegetation that was accustomed to fire. Many of the sites cored are in areas now protected as some form of state or national park, and the cores also document changes in vegetation with the new form of land use. In several cases burning decreased again and there has been a degree of return to prior vegetation communities, as has been the case in the Hawkesbury-Nepean, the NSW south coast and East Gippsland. Changes in sedimentation rates, however, along with the continued presence of exotic species, the ongoing absence of Aboriginal management regimes and the increasing pressure of climate change mean that the 'restoration' of these environments is illusory and impossible to achieve.

A synthesis of cores from 19 locations in south-western Victoria, south-eastern South Australia and south-western Western Australia provides a broad overview of vegetation change in the parts of Australia where a Mediterranean-type climate prevails (Dodson 2001). Throughout this climatic zone the palynological evidence indicates that the introduction of exotic species following British settlement represented the most significant change to vegetation since the replacement of grasslands with shrubs at the end of the Pleistocene. Exotic species that have been most successful in this zone have been those from parts of the world with similar climates and include grasses from the eastern Mediterranean and shrubs from southern Africa.

Pollen cores are not the only means of accessing pre-European vegetation. One study compared early explorers' accounts with aerial photography to map changes to vegetation cover in arid western Queensland (Fensham 2008). The study found that in the first decades of British settlement in the region, ca. 1860s–1940s, vegetation change was minimal and there was little difference in the distribution or density of woody species. It was not until after the Second World War that extensive land clearance in the region caused significant change in the vegetation. Another study of arid inland Australia used carbon isotope analysis of the diet of emus as a proxy for measuring vegetation change in the Lake Eyre basin (Johnson et al. 2005). Emus are large flightless birds with a diet of grasses (C^3 species) and shrubs (C^4 species). In the study a sample of emu eggshell dating from the early Holocene to the present was analysed and changing C^3/C^4 ratios measured. The authors found that there was a significant reduction in the quantity of grass species in the diet in the modern period. After the arrival of British pastoralists in the 1870s overgrazing and then drought in the 1890s severely reduced vegetation cover and triggered widespread erosion. Subsequent revegetation has favoured woody shrubs and trees rather than the native grasses that were maintained by Aboriginal burning. Stable isotope analysis is not yet extensively used for examining recent environmental change but it is one with considerable potential (Witt 2002). An early application examined C^3/C^4 ratios in sheep faeces deposited annually beneath sheering sheds (Witt et al. 1997). Although the two sheds used in the study had only been in use in the twentieth century the method identified changes in sheep diet that paralleled vegetation changes seen in aerial photography.

Some of the challenges when integrating documentary and environmental data are highlighted by debate around cores from Little Llangothlin Lagoon near Armidale in central New South Wales. The authors of the original study (Gale and Haworth 2002; Gale et al. 2004) measured a series of cores from across the lake. They identified a dramatic increase in sedimentation rates associated with changes in geochemistry and with changes in pollen that indicated a rapid decrease in casuarina trees (sheoaks). Using ^{210}Pb dating they located the timing of this event at ca. 1800 A.D. and argued that it was the result of the arrival of European pastoralists. At that time, grazing and land clearance reduced native forest cover that in turn caused erosion and increased sedimentation in the Lagoon. This conclusion was highly significant because it pushed the date of European expansion into this region well beyond the 1830s settlement known from documentary records and made it the earliest inland settlement in Australia. The study was challenged almost immediately, with initial criticism questioning the validity of the dating methods and the interpretation of the sedimentary changes as outside the range of Holocene variability (Tibby 2004). Later challenges were based on the analysis of new cores taken from the same lagoon (Woodward et al. 2011). Dating of the new samples using ^{210}Pb and radiocarbon suggested that the erosion event occurred much earlier than previously suggested and was early Holocene in age. Critics also argued that the pollen indicated there was no appreciable change in vegetation cover in the mid-nineteenth century that could be associated with European arrival.

While ecological history tends to emphasise changes in vegetation it is important to note that there have also been significant changes to the surface of the continent since European arrival. Cores used to study pollen sequences also contain information about rates of sedimentation. From these it is clear that increased erosion caused by a number of settler land-use activities is one of the widespread markers of British colonisation (Dodson and Mooney 2002; Wasson et al. 1996). It was not until the late 1960s that geomorphologists began to recognise that the prevalence of deeply incised creek lines in Australia was the product of settler activity (see review in Bird 1982). Crucial to this discovery was the use of historical sources that documented the observations of early European explorers and settlers and recorded the form of waterways and ponds on early maps. Before settler colonisation, watercourses were discontinuous chains of ponds and wetlands that relied on heavy rain to overflow the ponds and join them into a stream. The ponds drought-proofed the land by keeping water available for plants, animals and people. Settler activity disrupted this by draining the wetlands, clearing vegetation, grazing sheep and cattle and introducing rabbits. These activities caused rain to bite into the watercourses, converting the chains of ponds into continuous streams in incised channels up to 15 metres deep, with water draining quickly away (in Bird 1982; Eyles 1977).

Settler-driven anthropogenic change altered entire river systems. As areas at the top of catchments eroded, the sediment accumulated downstream in wetlands and filled estuaries. A study of 16 cores from wetlands along the Murray-Murrumbidgee river systems between Wagga Wagga and the Murray mouth showed that all the wetlands had markedly increased rates of sedimentation after British settlement. Sediment deposition was accompanied by the appearance of exotic pollen species and by changes in diatom ratios that indicated declining water quality (Gell et al. 2009). Lake cores in south-western Victoria likewise showed exotic pollens, increased charcoal frequencies and a doubling of sedimentation rates after the arrival of pastoralists (Mooney and Dodson 2001). The profound disturbances to river catchments in the new towns and cities are demonstrated in the study of a core taken from Bolin Billabong along the Yarra River in Melbourne. Diatoms from this site showed 30 times more sediment accumulation in the years following British settlement than had previously been the case (Leahy et al. 2005).

When rivers flooded the eroded sediment was redeposited on floodplains downstream. Modern soil scientists call this material post-settlement alluvium (PSA) because of its association with European colonisation around the world (Portenga et al. 2016; Rustomji and Pietsch 2007; Starr 1989; Wasson et al. 1998). PSA travels tens of kilometres downstream and can be several metres thick, burying previous land surfaces and at times incorporating settler artefacts. Despite its landscape scale and distribution, this is clearly an archaeological deposit that is the product of human activity (Lawrence et al. 2016).

By the 1980s and 1990s research was establishing that most erosion in Australian streams is caused by gullying (Starr 1989; Brierley and Mum 1997; Wasson et al. 1996, Wasson et al. 1998). A range of studies explicitly tied the transformation of river systems to the effects of European settlement. They took a catchment-scale approach and integrated the geomorphology of rivers with coring for pollen analysis and dating and with the study of documentary history of the catchments. In most parts of the world, alluvial erosion occurs as rilling or widely distributed sheetwash across exposed ground (Armstrong and Mackenzie 2002; Wasson et al. 1996). In Australia, however, erosion is localised in the upper sections of catchments where stormwater runoff flows into narrow channels (Wasson et al. 1998). Significantly, studies of gullying have demonstrated that erosion was most severe in the first few decades of settler colonisation and is not the result of purely local processes such as bank erosion or of global climatic factors (Rustomji and Pietsch 2007). By the early twentieth century erosion rates slowed and then even reversed in some places following the Second World War with the implementation of new farming and land conservation practices (Armstrong and Mackenzie 2002; Brierley et al. 1999; Rustomji and Pietsch 2007).

11.4 Connecting the Dots: The Potential of Integrated Approaches

The combination of historical ecology and environmentally informed historical archaeology has great potential to inform our understanding of the recent past and our capacity to live sustainably in the future. There are challenges, however, in integrating environmental data with documentary evidence when looking at anthropogenic change over the past 200 years. One of the greatest challenges is that of working simultaneously with sets of data to which different temporal scales apply. Even the finest-grained chronometric dating continues to have error margins that far exceed dates obtained from documentary sources. Sediment cores can reveal variation in vegetation, the use of fire, water quality and sediment accumulation but attributing the changes to human causes requires not only temporal precision but a solid understanding of local settlement histories. There can be profound differences in behaviour between the first British arrivals and the second generation and thus their effects on the land. Historical circumstances resulted in different ways of using the land which would have had different environmental effects. The first British settlers to move inland in the 1820s and 1830s were graziers who occupied large properties on a leasehold system. The graziers used shepherds (often convicts) to manage their sheep and cattle and direct them between water supplies and grazing areas. In the 1840s the end of convict transportation and the collapse of the wool market led to widespread de-stocking while in the 1860s the large pastoral properties were broken up into smaller farms with more intensive clearing and the introduction of plough agriculture. New technologies such as wire fences in the 1870s also changed the way stock were managed and directed on the land. So a margin of error of 20 years in the dating of cores may seem quite precise to a natural scientist but may still be too broad to encompass changes in human behaviour.

Understanding different spatial variation is also crucial because the nature of anthropogenic change following British settlement was locally specific. The charcoal record shows that in most places settlers used fire more heavily than did Aboriginal people, but this was not a universal pattern. Some studies show that fire use decreased in some places when Aboriginal managers were no longer present (Dodson et al. 1993). Sedimentation rates in most catchments were highest in the decades immediately following British settlement, but in the wetlands along the Murray sedimentation continues to increase (Gell et al. 2009). This variability may have several causes. It may depend on previous Aboriginal land management and food production practices, such as low-frequency burning to maintain forests for the production of nuts (Cosgrove 2005) versus higher-frequency burning for yam cultivation (Gott 2008). It may also depend on the type and location of settler activity, such as pastoralism or agriculture or the exploitation of economic mineral deposits. It is also important to understand the changes that have occurred since settler colonisation, including new farming techniques that reduce erosion, Landcare initiatives that have encouraged reforestation, and the radically different management regimes imposed when land has been converted to national parks and reserves.

The analytical scale used is therefore of considerable importance. At small geographic and temporal scales what is most apparent is variability. Documentary records and environmental data show events and oscillations that occur in human time frames. This scale is the one that is important for understanding the precise dimensions of human intervention in the environment and for measuring the response and resilience of natural systems. This is the scale at which historical explanation is typically produced. Moving to geological and global scales of time and space, the most apparent pattern is the continent-wide environmental transformation that has occurred in the 200 years since British settlement. Despite local variations, it is abundantly clear that there has been a significant disruption to ecosystems and landforms and that adjustment to the new conditions is continuing. Historical archaeologists are accustomed to working locally at the scale of the event, making use of the fine-grained chronology of associated documents. Most archaeologists, however, work at the scale of geological time measuring change in centuries or millennia. Historical ecologists are accustoming themselves to working at the decadal and century scales needed to explain anthropogenic drivers of environmental change. Historical archaeologists can work with them by drawing on the long-term explanatory models routinely employed in other fields of archaeology.

When the archaeological and environmental record of European colonisation is viewed through a long-term lens it is clear that both are in many ways structurally similar to records of other episodes of human expansion and ecological transformation. Problems of resolution and explanation find their parallels in the spread of modern humans into places already occupied by *Homo erectus* or *Homo neandertalensis* populations, the Pleistocene colonisation of Australia and the Americas, the colonisation of the Pacific, and the spread of agriculture into northern Europe. In all of these cases there must have been a moment of impact, a period of a few generations at most when everything changed for the colonisers, the colonised and the environments in which they lived. In each of those cases we struggle to find the evidence of frontier violence that must have occurred and we struggle to explain the human role in the ecological transformations that followed. The documentary record available for the colonisations of the modern period means that we have an additional source of evidence from which we can generate questions and against which to test our explanations.

Part of the process of drawing on long-term archaeological models is connecting settler land management with deep-time trajectories of Aboriginal management. This has several implications for archaeologies of colonisation. The first is that it necessarily means challenging settler perceptions of a ‘wild’ and ‘waste’ landscape that awaited exploitation. The extent and character of ecological niches including grasslands and timbered areas was due to the deliberate manipulation of fire to ‘clean’ the land, a process that over tens of thousands of years favoured particular plant species and determined their spatial distribution (Jones 1968; Pyne 1991). The best-known example of species change since the arrival of Aboriginal people is the extinction of the megafauna, the giant kangaroos, wombats, emus and crocodiles that once proliferated. The exact role of human activity in this process remains controversial (Field et al. 2013; Flannery 1994; Hiscock 2008) but there is no doubt that

Aboriginal people experienced the disappearance of these animals. There was no 'wilderness' on the Australian continent in 1788 and there is none now. The environment to which British colonists adapted was one that was already accustomed to human use.

The second implication is that settler colonisation had both direct and indirect effects on the Australian landscape. The direct effects are obvious and well documented, including the clearing of forests, the extinction of indigenous species and the introduction of exotic plants and animals. The indirect effect that is only now being understood is the extent to which the disruption of Aboriginal burning patterns has changed the distribution of plants and animals and the composition of ecological communities across the continent. Public land managers in particular are becoming aware that simply excluding settler farmers and timber-getters from national parks is not enough to re-establish a pre-European environment (Bowman 2001; Haberle et al. 2006). Botanist Beth Gott (2008) observes that we have failed to comprehend the extent to which traditional Aboriginal practices created the biodiversity that parks staff now work to restore by removing people. Working with traditional owners is an increasingly important part of successful conservation strategy as has been demonstrated by a number of initiatives led by the New South Wales National Parks and Wildlife Service (Brown 2010b; Byrne and Nugent 2004; English 2002; Harrison 2004). Water management is as much a part of this process as fire management. The Murray-Darling Basin Authority's Plan for the region is to introduce provision for 'cultural flows' that release water for traditional owners in addition to 'environmental flows'. In Victoria access to water has been fundamental for the Gunditjmara people revitalising their ancient network of eel-traps at Budj Bim (Gunditjmara People with Gib Wettenhall 2011).

A third implication of connecting recent historical and deep-time anthropogenic change is that it must have consequences for the kinds of questions asked by archaeologists. If we are going to keep studying adaptation, we must develop a new set of questions to ask and a new set of perceptions through which to view the process. The environment to which the settlers adapted was already a socialised, human environment. What changed were the cultural and technological systems that shaped adaptation. In that context what matters is how the new arrivals were able to impose their regimes, as much as what those regimes were. How intense were the settler interventions, and did that intensity vary? What practices were the most damaging in the changes caused? What role did Aboriginal knowledge play in shaping settler practice? What also matters is how the process of change evolved after the first generation of settlers. What hybrid landscapes and practises emerged in subsequent decades? What was the timing and rate of change?

Answers to these questions will be found in the fine-grained detail of local archaeological and ecological studies that map the impact of particular past activities on particular environments, that document how the environment has responded over time and that describe the ongoing interaction of people, place and natural systems. This requires a more thorough integration of historical, archaeological and environmental data for the post-contact period that mirrors the close working relationships already developed by archaeologists and natural scientists studying the more distant past. Only then will we be able to grasp the complexities of the processes that have unfolded over time and that are creating the landscape we inhabit. Only then will we start to develop the deeper sense of place that is necessary for responding to the future. Naming the Anthropocene is an acknowledgement of the extent of entanglement between human action and environmental processes. Archaeologists know that the entanglement is an ancient one and historical archaeologists have the capacity to situate recent action in that deep-time continuum.

References

Anschuetz, K. F., Wilshusen, R. H., & Scheick, C. L. (2001). An archaeology of landscapes: Perspectives and directions. *Journal of Archaeological Research, 9*, 157–211.

Armstrong, J. L., & Mackenzie, D. H. (2002). Sediment yields and turbidity records from small upland subcatchments in the Warragamba Dam catchment, southern New South Wales (statistical data included). *Australian Journal of Soil Research, 40*(4), 557.

Atkinson, M. (2001). Keeping the land clean: An historical archaeology of landscape and garden creation at Murrungowar, Victoria. *Studies in the Histories of Gardens and Designed Landscapes, 21*(1), 19–26.

Bickford, S., & Gell, P. (2005). Holocene vegetation change, Aboriginal wetland use and the impact of European settlement on the Fleurieu Peninsula, South Australia. *The Holocene, 15*(2), 200–215.

Binford, L. (1982). The archaeology of place. *Journal of Anthropological Archaeology, 1*, 5–31.

Bird, J. F. (1982). Channel incision at Eaglehawk Creek, Gippsland, Victoria, Australia. *Proceedings of the Royal Society of Victoria, 94*, 11–22.

Birmingham, J. (2000). Resistance, creolization or optimal foraging at killalpaninna mission, South Australia. In R. Torrence & A. Clarke (Eds.), *The archaeology of difference: Negotiating cross-cultural engagements in Oceania* (pp. 360–405). London: Routledge.

Birmingham, J., & Jeans, D. (1983). The Swiss Family Robinson and the archaeology of colonisations. *Australian Journal of Historical Archaeology, 1*, 3–14.

Blake, N. (2010). Diet in urban and rural nineteenth-century New South Wales: The evidence from the faunal remains. *Australasian Historical Archaelogy, 28*, 25–34.

Bowman, D. (2001). Future eating and country keeping: What role has environmental history in the management of biodiversity? *Journal of Biogeography, 28*, 549–564.

Bowman, D. (2002). Preface: Measuring and imagining: Exploring centuries of Australian landscape change. *Australian Journal of Botany, 50*(4), i–iii.

Braje, T. J. (2016). Evaluating the Anthropocene: Is there something useful about a geological epoch of humans? *Antiquity, 90*(350), 504–512.

Brierley, G. J., & Mum, C. P. (1997). European impacts on downstream sediment transfer and bank erosion in Cobargo catchment, New South Wales, Australia. *Catena, 31*(1), 119–136.

Brierley, G., Cohen, T., Fryers, K., & Brooks, A. (1999). Post-European changes to the fluvial geomorphology of began catchment, Australia: Implications for river ecology. *Freshwater Biology, 41*(4), 839.

Brown, S. (2010a). Buggering around in the backyard: Creating attachment to place through archaeology and material culture. *Australian Archaeology, 71*, 74–78.

Brown, S. (2010b). *Cultural landscapes: A practical guide for park management*. Sydney: Department of Environment Climate Change and Water.

Brown, A. G., Tooth, S., Bullard, J. E., Thomas, D. S. G., Chiverrell, R. C., Plater, A. J., Murton, J., Thorndycraft, V. R., Tarolli, P., Rose, J., Wainwright, J., Downs, P., & Aalto, R. (2017).

The geomorphology of the Anthropocene: Emergence, status and implications. *Earth Surface Processes and Landforms, 42*(1), 71–90.
Burke, H. (1999). *Meaning and ideology in historical archaeology: Style, social identity, and capitalism in an Australian town*. New York: Kluwer Academic/Plenum Publishers.
Burke, S., Di Marco, P., & Meath, S. (2010). The land 'flow[ing] ...With milk and honey': Cultural landscape changes at Peel Town Western Australia 1829–1830. *Australasian Historical Archaelogy, 28*, 5–12.
Buxton, G. L. (1967). *The Riverina, 1861–1891: An Australian regional study*. Melbourne: Melbourne University Press.
Byrne, D., & Nugent, M. (2004). *Mapping attachment*. Sydney: Department of Environment and Conservation.
Casella, E. (2006). Transplanted technologies and rural relics: Australian industrial archaeology and questions that matter. *Australasian Historical Archaeology, 24*, 65–76.
Casey, M. (2006). Remaking Britain: Establishing British identity and power at Sydney cove, 1788-1821. *Australasian Historical Archaeology, 24*, 87–98.
Chakrabarty, D. (2009). The climate of history: Four theses. *Critical Inquiry, 35*(winter 2009), 197–222.
Clark, R. L. (1990). Ecological history for environmental management. *Proceedings of the Ecological Society of Australia, 16*, 1–21.
Colley, S. (2005). Marine shell from Australian historic sites: Coding, recording and research design. *Australasian Historical Archaeology, 23*, 71–78.
Colley, S. (2006). A preliminary beef meat cuts typology for nineteenth-century Sydney and some methodological issues. *Australasian Historical Archaeology, 24*, 47–54.
Connah, G. (1996). Bagot's Mill: Genesis and revelation in an archaeological research project. *Australasian Historical Archaeology, 12*, 3–55.
Cosgrove, R. (2005). Coping with noxious nuts. *Nature Australia, 28*(6), 47–53.
Crutzen, P., & Steffen, W. (2003). How long have we been in the Anthropocene era? *Climate Change, 61*, 251–257.
Crutzen, P., & Stoermer, E. (2000). The 'Anthropocene'. *Global Change Newsletter, 41*, 17–18.
Cummins, R. (1989). Scouring the clip: Boom and bust on Woolscour Lane. *Australian Journal for Historical Archaeology, 7*, 23–28.
Davies, P. (2005). Space and structure at an Australian forest sawmill. *Historical Archaeology, 39*(4), 51–64.
Davies, P., & Garvey, J. (2013). Early Zooarchaeological evidence for *Mus musculus* in Australia. *International Journal of Osteoarchaeology, 23*(1), 106–111.
Dodson, J. (2001). Holocene vegetation change in the Mediterranean-type climate regions of Australia. *The Holocene, 11*(6), 673–680.
Dodson, J., & Mooney, S. D. (2002). An assessment of historic human impact on south-eastern Australian environmental systems, using late Holocene rates of environmental change. *Australian Journal of Botany, 50*, 455–464.
Dodson, J., McRae, V., Molloy, K., Roberts, F., & Smith, J. (1993). Late Holocene human impact on two coastal environments in New South Wales, Australia: A comparison of Aboriginal and European impacts. *Vegetation History and Archaebotany, 2*(2), 89–100.
Duncan, B. (2007). Using anthropogenic geomorphological change associated with historic marine infrastructure to predict the location of coastal archaeological sites in Queenscliffe, Victoria. *Australasian Historical Archaelogy, 25*, 71–86.
Edgeworth, M. (2011). *Fluid pasts: Archaeology of flow*. London: Bloomsbury Publishing.
Edgeworth, M. (2014a). Archaeology of the Anthropocene. *Journal of Contemporary Archaeology, 1*(1), 73–132.
Edgeworth, M. (2014b). The relationship between archaeological stratigraphy and artificial ground and its significance in the Anthropocene. In C. N. Waters, J. Zalasiewicz, M. Williams, M. Ellis, & A. M. Snelling (Eds.), *Basis for the Anthropocene* (pp. 91–108). Bath: Lyell Collection Special Publications 395: The Geological Society Publishing House.

Egloff, B. (1994). From Swiss Family Robinson to Sir Russell Drysdale: Towards changing the tone of historical archaeology in Australia. *Australian Archaeology, 39*, 1–9.
English, A. (2002). *The sea and the rock gives us a feed: Mapping and managing Gumbaingirr wild resource use places*. Sydney: NSW National Parks and Wildlife Service.
Erlandson, J. M., & Braje, T. (2014). Archaeology and the Anthropocene. *Anthropocene, 4*, 1–7.
Eyles, R. J. (1977). Changes in drainage networks since 1820, southern tablelands, N.S.W. *Australian Geographer, 13*(6), 377–386.
Fensham, R. J. (2008). Leichhardt's maps: 100 years of change in vegetation structure in inland Queensland. *Journal of Biogeography, 35*(1), 141–156.
Field, J., Wroe, S., Trueman, C., Garvey, J., & Wyatt-Spratt, S. (2013). Looking for the archaeological signature in Australian megafaunal extinctions. *Quaternary International, 285*(8 February 2013), 76–88.
Flannery, T. (1994). *The future eaters: An ecological history of the Australian lands and people*. Chatswood: Reed Books.
Fowler, M., Roberts, A., McKinnon, J., O'Loughlin, C., & Graham, F. (2014). 'They camped here always': 'Archaeologies of attachment' in a seascape context at Wardang Island (Waraldi/Waradharldhi) and Point Pearce Peninsula (Burgiyana), South Australia. *Australasian Historical Archaelogy, 32*, 14–22.
Gale, S. J., & Haworth, R. J. (2002). Beyond the limits of location: Human environment disturbance prior to official European contact in early colonial Australia. *Archaeology in Oceania, 37*, 123–136.
Gale, S. J., Haworth, R. J., Cook, D. E., & Williams, N. J. (2004). Human impact on the natural environment in early colonial Australia. *Archaeology in Oceania, 39*(3), 148–156.
Gammage, B. (2011). *The biggest estate on earth: How aborigines made Australia*. Sydney: Allen & Unwin.
Gell, P. A., Stuart, I. M., & Smith, J. D. (1993). The response of vegetation to changing fire regimes and human activity in east Gippsland, Victoria, Australia. *The Holocene, 3*(2), 150–160.
Gell, P., Fluin, J., Tibby, J., Hancock, G., Harrison, J., Zawadzki, A., Haynes, D., Khanum, S., Little, F., & Walsh, B. (2009). Anthropogenic acceleration of sediment accretion in lowland floodplain wetlands, Murray–Darling Basin, Australia. *Geomorphology, 108*(1), 122–126.
Gibbs, M. (1998). Colonial boats and foreign ships: The history and archaeology of nineteenth century whaling in Western Australia. In S. Lawrence & M. Staniforth (Eds.), *The archaeology of whaling in southern Australia and New Zealand* (pp. 36–47). Canberra: Brolga Press for the Australasian Society for Historical Archaeology and the Australian Institute of Maritime Archaeology.
Gibbs, M. (2005). The archaeology of subsistence on the maritime frontier: Faunal analysis of the cheyne beach whaling station 1845–1877. *Australasian Historical Archaeology, 23*, 115–122.
Godwin, L., & L'Oeste-Brown, S. (2012). Water, water everywhere: Attempts at drought-proofing properties using surface water infrastructure in central West Queensland in the early 1880s. *Australian Archaeology, 74*, 55–70.
Gott, B. (2008). Indigenous use of plants in South-Eastern Australia. *Telopea, 12*(2), 223.
Grimwade, G. (1999). The canning stock route: Desert stock route to outback tourism. *Australasian Historical Archaeology, 16*, 70–79.
Guiry, E. J., Harpley, B., Jones, Z., & Smith, C. (2014). Integrating stable isotope and zooarchaeological analyses in historical archaeology: A case study from the urban nineteenth-century Commonwealth Block site, Melbourne, Australia. *International Journal of Historical Archaeology, 18*(3), 415–440.
Guiry, E. J., Staniforth, M., Nehlich, O., Grimes, V., Smith, C., Harpley, B., Noël, S., & Richards, M. P. (2015). Tracing historical animal husbandry, meat trade, and food provisioning: A multi-isotopic approach to the analysis of shipwreck faunal remains from the *William Salthouse*, Port Phillip, Australia. *Journal of Archaeological Science: Reports, 1*, 21–28S.
Gunditjmara People with Gib Wettenhall. (2011). *The people of Budj Bim: Engineers of aquaculture, builders of stone house settlements and warriors defending country*. Melbourne: emPress.

Haberle, S. G., Tibby, J., Dimitriadis, S., & Heijnis, H. (2006). The impact of European occupation on terrestrial and aquatic ecosystem dynamics in an Australian tropical rain forest: Consequence and significance of disturbance. *The Journal of Ecology, 94*(5), 987–1002.

Hancock, W. K. (1972). *Discovering Monaro: A study of man's impact on his environment*. Cambridge, UK: Cambridge University Press.

Hardesty, D. (2009). Historical archaeology and the environment: A North American perspective. In T. Majewski & D. Gaimster (Eds.), *International handbook of historical archaeology* (pp. 67–76). New York: Springer.

Harrington, J. (1996). The lime-burning industry in Victoria: An occupance approach. *Australasian Historical Archaeology, 14*, 19–24.

Harrison, R. (2004). *Shared landscapes: Archaeologies of attachment and the pastoral industry in New South Wales*. Sydney: University of New South Wales Press.

Head, L. (2014). Contingencies of the Anthropocene: Lessons from the 'neolithic'. *The Anthropocene Review, 1*(2), 113–125.

Head, L. (2016). *Hope and grief in the Anthropocene: Re-conceptualising human-nature relations*. Abingdon: Taylor and Francis.

Higginbotham, E., Macphail, M., & Davey, B. (1988). The soil and pollen analysis of part of the gardens of First Government House, Sydney. *Australian Journal of Historical Archaeology, 6*, 49–56.

Hiscock, P. (2008). *The archaeology of ancient Australia*. London: Routledge.

Hodder, I. (2012). *Entangled: An archaeology of the relationships between humans and things*. London: Wiley-Blackwell.

Hoskins, W. G. (1965). *The making of the English landscape*. London: Hodder and Stoughton.

Howell-Muers, S. (2000). Nineteenth-century diet in Victoria: The faunal remains from Viewbank. *Australasian Historical Archaeology, 18*, 39–46.

Jack, R. I. (1979). Introduction. In J. Birmingham, R. I. Jack, & D. Jeans (Eds.), *Australian Pioneer Technology: Sites and relics* (pp. 1–10). Richmond: Heinemann Educational Australia.

Jack, R. I., Holmes, K., & Kerr, R. (1984). Ah Toy's garden: A Chinese market-garden on the Palmer River goldfield, North Queensland. *The Australian Journal of Historical Archaeology, 2*, 51–58.

Jack, R.I. & Cremin, A. (1994). Australia's age of iron: History and archaeology. South Melbourne: Oxford University Press and Sydney University Press.

Jeans, D. N. (1984). *Australia's historic landscapes*. Sydney: Allen and Unwin.

Johnson, A. G. (2000). Fine resolution palaeoecology confirms anthropogenic impact during the late Holocene in the lower Hawkesbury valley, NSW. *Australian Geographer, 31*(2), 27.

Johnson, B., Miller, G., Magee, J., Gagan, M., Fogel, M., & Quay, P. (2005). Carbon isotope evidence for an abrupt reduction in grasses coincident with European settlement of Lake Eyre, South Australia. *The Holocene, 15*(6), 888–896.

Jones, R. (1968). Fire stick farming. *Australian Natural History, 16*, 224–228.

Koppi, A. J., Davey, B., & Birmingham, J. (1985). The soils in the old vineyard at Camden Park estate, Camden, new South Wales. *Australian Journal of Historical Archaeology, 3*, 24–30.

Lawrence, S., & Davies, P. (2012). Learning about landscape: Archaeology of water management in colonial Victoria. *Australian Archaeology, 74*, 47–54.

Lawrence, S., & Tucker, C. (2002). Sources of meat in colonial diets: Faunal evidence from two nineteenth-century Tasmanian whaling stations. *Environmental Archaeology, 7*, 23–34.

Lawrence, S., Davies, P., & Turnbull, J. (2016). The archaeology of Anthropocene rivers: Water management and landscape change in gold rush Australia. *Antiquity, 90*(352), 1–15.

Lawrie, R. (1999). Soil chemical properties at historical archaeological sites in Sydney. *Australasian Historical Archaelogy, 17*, 70–78.

Leahy, P. J., Tibby, J., Kershaw, A. P., Heijnis, H., & Kershaw, J. S. (2005). The impact of European settlement on Bolin Billabong, a Yarra River floodplain lake, Melbourne, Australia. *River Research and Applications, 21*(2–3), 131–149.

Lewis, S., & Maslin, M. (2015). Defining the Anthropocene. *Nature, 519*(12 March), 171–180.

Lightfoot, K., Panich, L., Schneider, T., & Gonzalez, S. (2013). European colonialism and the Anthropocene: A view from the Pacific coast of North America. *Anthropocene, 4(*101–115.

Lydon, J. (2009). *Fantastic dreaming: The archaeology of an aboriginal mission*. Lanham: Altamira.

Macklin, M., Lewin, J., & Jones, A. F. (2014). Anthropogenic alluvium: An evidence-based meta-analysis for the UK Holocene. *Anthropocene, 6*, 26–38.

Macphail, M. (1999). A hidden cultural landscape: Colonial Sydney's plant microfossil record. *Australasian Historical Archaeology, 17*, 79–109.

Macphail, M., & Casey, M. (2008). 'News from the interior': What can we tell from plant microfossils preserved on historical archaeological sites in colonial Parramatta? *Australasian Historical Archaeology, 26*, 45–70.

Major, J., Smith, C., & Mackay, R. (2017). Reconstructing landscape: Archaeological investigations of the Royal Exhibition Building's western forecourt, Melbourne. *International Journal of Historical Archaeology*. https://doi.org/10.1007/s10761-017-0414-5.

Mate, G. (2010). *Mining the landscape: Finding the social in the industrial through an archaeology of the landscapes of Mount Shamrock*. Unpublished PhD dissertation, School of Social Science, Brisbane: University of Queensland.

Mayne, A., & Murray, T. (2001). The archaeology of urban landscapes: Explorations in slumland. In A. Mayne & T. Murray (Eds.), *The archaeology of urban landscapes: Explorations in slumland* (pp. 1–10). Cambridge, UK: Cambridge University Press.

McGowan, B. (2001). Mullock heaps and tailing mounds: Environmental effects of alluvial goldmining. In I. McCalman, A. Cook, & A. Reeves (Eds.), *Gold: Forgotten histories and lost objects of Australia* (pp. 85–102). Cambridge, UK: Cambridge University Press.

McGowan, B. (2005). Chinese market gardens in southern and western New South Wales. *Australian Humanities Review, 36*, 1–5.

McLoughlin, L. (2000). Shaping Sydney Harbour: Sedimentation, dredging and reclamation 1788–1990s. *Australian Geographer, 31*(1), 183–208.

Meinig, D. W. (1962). *On the margins of the good earth: The south Australian wheat frontier 1869–1884*. Chicago: McNally.

Mooney, S. D., & Dodson, J. R. (2001). A comparison of the environmental changes of the post-European period with those of the preceding 2000 years at Lake Keilambete, South-Western Victoria. *Australian Geographer, 32*(2), 163–179.

Mrozowski, S. (2006). Environments of history: Biological dimensions of historical archaeology. In M. Hall & S. Silliman (Eds.), *Historical archaeology* (pp. 23–41). Oxford: Blackwell.

Mrozowski, S. (2010). New and forgotten paradigms: The environment and economics in historical archaeology. *Historical Archaeology, 44*(3), 117–127.

Paterson, A. (2008). *The lost legions: Culture contact in colonial Australia*. Lanham: Altamira Press.

Paterson, A. (2013). Enduring contact: Australian perspectives on environmental and social change. *Occasion: Interdisciplinary Studies in the Humanities, 5*, 1–17.

Pearson, M. (1984). The excavation of the Mount Wood woolscour, Tibooburra, N.S.W. *Australian Journal of Historical Archaeology, 2*, 38–50.

Pearson, M. (1993). The good oil: Eucalyptus oil distilleries in Australia. *Australian Journal of Historical Archaeology, 11*, 99–107.

Pearson, W. (1997). Water power in a dry continent: The transfer of watermill technology from Britain to Australia in the nineteenth century. *Australasian Historical Archaeology, 14*, 46–62.

Piddock, S., Smith, P., & Pate, F. (2009). A changed landscape: Horticulture and gardening in the Adelaide Hills Face Zone, South Australia, 1836–1890. *Historical Archaeology, 43*(3), 65–81.

Portenga, E. W., Bishop, P., Gore, D. B., & Westaway, K. E. (2016). Landscape preservation under post-European settlement alluvium in the south-eastern Australian tablelands, inferred from portable OSL reader data.(report). *Earth Surface Processes and Landforms, 41*(12), 1697.

Powell, J. M. (1970). *The public lands of Australia Felix: Settlement and land appraisal in Victoria 1834–1891*. Melbourne: Oxford University Press.

Powell, J. M. (1976). *Environmental management in Australia, 1788–1914*. Melbourne: Oxford University Press.
Powell, J. M. (1989). *Watering the garden state: Water, land and community in Victoria 1834–1988*. Sydney: Allen & Unwin.
Powell, J. M. (1996). Historical geography and environmental history: An Australian interface. *Journal of Historical Geography, 22*(3), 253–273.
Pyne, S. (1991). *Burning bush: A fire history of Australia*. New York: Henry Holt and Company.
Robin, L. (2013). Histories for changing times: Entering the Anthropocene? *Australian Historical Studies, 44*, 329–240.
Rohe, R. (1983). Man as geomorphic agent: Hydraulic mining in the American west. *The Pacific Historian, 27*, 5–16.
Russell, L. (2004). 'Either, or, neither, nor': Resisting the production of gender, race, and class dichotomies in the pre-colonial period. In E. C. Casella & C. Fowler (Eds.), *The archaeology of plural and changing identities: Beyond identification* (pp. 33–51). New York: Springer.
Rustomji, P., & Pietsch, T. (2007). Alluvial sedimentation rates from southeastern Australia indicate post-European settlement landscape recovery. *Geomorphology, 90*(1–2), 73–90.
Sauer, C. (1925). The morphology of landscapes. *University of California Publications in Geography, 2*, 19–54.
Simons, A., & Maitri, M. (2006). The food remains from Casselden Place, Melbourne, Australia. *International Journal of Historical Archaeology, 10*(4), 357–374.
Smith, P., & Pate, F. D. (2006). Preface. In P. Smith, F. D. Pate, & R. Martin (Eds.), *Valleys of stone: The archaeology and history of Adelaide's Hills Face* (pp. ix–xviii). Belair: Kopi Books.
Smith, P., Pate, F. D., & Martin, R. (2006). *Valleys of stone: The archaeology and history of Adelaide's Hills Face*. Belair: Kopi Books.
Starr, B. (1989). Anecdotal and relic evidence of the history of gully erosion and sediment movement in the Michelago Creek catchment area, NSW. *Australian Journal of Soil and Water Conservation, 2*, 26–31.
Steward, J. (1955). The concept and method of cultural ecology. In J. Steward (Ed.), *The theory of culture change* (pp. 3–42). Urbana: University of Illinois Press.
Strang, V. (2004). *The meaning of water*. Oxford: Berg.
Sutter, P. (2015). *Let us now praise famous gullies: Providence canyon and the soils of the south*. Athens: University of Georgia Press.
Thomas, N. (1991). *Entangled objects: Exchange, material culture, and colonialism in the Pacific*. Cambridge, MA: Harvard University Press.
Tibby, J. (2004). Assessing the impact of early colonial Australia on the physical environment: A comment on Gale and Haworth (2002). *Archaeology in Oceania, 39*(3), 144.
Wadham, S., Kent Wilson, R. K., & Wood, J. (Eds.). (1950). *Land utilization in Australia* (2nd ed.). Melbourne: Melbourne University Press.
Walter, R. C., & Merritts, D. J. (2008). Natural streams and the legacy of water-powered mills. *Science, 319*, 299–304.
Wasson, R. J., Olive, L. J., & Rosewell, C. J. (1996). Rates of erosion and sediment transport in Australia. In *Erosion and sediment yield: Global and regional perspectives (Proceedings of the Exeter symposium)* (pp. 139–148). Wallingford: International Association of Hydrological Sciences.
Wasson, R. J., Mazari, R. K., Starr, B., & Clifton, G. (1998). The recent history of erosion and sedimentation on the Southern Tablelands of southeastern Australia: Sediment flux dominated by channel incision. *Geomorphology, 24*(4), 291–308.
Waters, C. N., Zalasiewicz, J., Summerhayes, C., Barnosky, A. D., Poirier, C., Gałuszka, A., Cearreta, A., Edgeworth, M., Ellis, E. C., Ellis, M., Jeandel, C., Leinfelder, R., McNeill, J. R., Richter, D. D., Steffen, W., Syvitski, J., Vidas, D., Wagreich, M., Williams, M., Zhisheng, A., Grinevald, J., Odada, E., Oreskes, N., & Wolfe, A. P. (2016). The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science, 351*(6269), 2622.

White, R. (1995). *The organic machine: The remaking of the Columbia River*. New York: Hill and Wang.

Willey, G. (1953). *Prehistoric settlement patterns in the Viru Valley, Peru*. Washington, D.C: Smithsonian Institution Press.

Williams, M. (1974). *The making of the South Australian landscape: A study in the historical geography of Australia*. London: Academic Press.

Winston-Gregson, J. H. (1984). People in the landscape: A biography of two villages. *Australian Journal of Historical Archaeology, 2*, 27–37.

Witt, G. B. (2002). Century-scale environmental reconstruction by using stable carbon isotopes: Just one method from a big bag of tricks. *Australian Journal of Botany, 50*, 441–445.

Witt, G. B., Moll, E. J., & Beeton, R. J. S. (1997). Sheep faeces under shearing sheds: A documentary of vegetation change using stable isotope analysis. *Rangeland Journal, 19*, 109–115.

Woodward, C., Chang, J., Zawadzki, A., Shulmeister, J., Haworth, R., Collecutt, S., & Jacobsen, G. (2011). Evidence against early-nineteenth-century major European-induced environmental impacts by illegal settlers in the New England tablelands, south eastern Australia. *Quaternary Science Reviews, 30*(27–28), 3743–3747.

Wright, R. (1989). *The bureaucrats' domain: Space and the public interest in Victoria, 1836–84*. Melbourne: Oxford University Press.

Young, G. (1985). Early German settlements in South Australia. *Australian Journal of Historical Archaeology, 3*, 43–55.

Chapter 12
The Anthropocene in Antarctica: Considering "Fixed" and "More Fluid" Perspectives of Analysis

Andrés Zarankin and Melisa A. Salerno

Abstract Starting in 1995, our research project seeks to learn more about human presence in Antarctica; in particular, though not exclusively, about sealers' encounters with the South Shetland Islands in the nineteenth century. In this chapter we discuss the material dimension of the Anthropocene in Antarctica from an archaeological point of view. First, we describe our initial approaches to the subject, when we were still constrained by an orthodox understanding of the material world. Second, we critically reflect on our previous work and explore new possibilities for analysis, considering a challenging definition of the material world, bodily experience, and the interconnectedness of the webs of life.

12.1 Introduction

The term *Anthropocene* has been proposed to officially name a new geological epoch based on human domination of earth's ecosystems, that is to say, the process of human expansion and interaction with different regions of the world, especially during modernity, when there was a change toward systematic and large-scale predation against nature and society (*sensu* Gonzalez-Ruibal in Solli et al. 2011). The name *Anthropocene* was popularized in 2000 by atmospheric chemist Paul J. Crutzen. An arbitrary date for defining the Anthropocene has been proposed based on stratigraphically recognizable evidence for major floral and faunal changes worldwide. Archaeologists have argued that the Anthropocene began around 10,000 years ago, after a variety of plant and animal species were domesticated (Erlandson and Braje 2013). These developments set in motion a cumulative process of human population growth, landscape modification, and environmental

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changes visible in Holocene soil, pollen, faunal, and other records around the world. The possibilities of using Anthropocene in archaeology have been explored in a recent volume edited by Matt Edgeworth (2014).

Some time ago we were invited by Edgeworth to contribute an article for that volume on the archaeology of the Anthropocene (Zarankin and Salerno 2014). On that occasion, we were asked to reflect on the case of Antarctica. We thought this was an interesting challenge. The notion of the Anthropocene opened up the possibility of discussing the relationship between "nature" and "culture"—two concepts that seemed to be pervasive among scholars dealing with the southern continent. As a first move, we decided to gather information on how human presence in Antarctica was defined by scholars approaching the Anthropocene on a global scale. We found out that, while some researchers held that Antarctica was part of the territory still being mostly shaped by the forces of nature (see, for instance, McCloskey and Spalding 1989), some others even separated Antarctica from other biomes they defined as anthropogenic (see Ellis and Ramankuty 2008).

Even though some studies acknowledged that human action could be responsible for causing the reduction of the ice sheet and the decline of animal colonies, among other things, much of the literature provided an image of Antarctica as a territory on the fringes of the Anthropocene. In general, the southern continent was associated with "nature" and "wilderness," a reality that was considered almost opposite to "culture." This representation helped essentialize the region, transforming it into a relict of an era when our species had not yet reached all the corners of the world. As archaeologists dealing with the history of Antarctica, including sealers' interactions with the South Shetland Islands in the nineteenth century, we rejected that idea. In our view, the "parameters" frequently used to "measure" the Anthropocene included compelling and overwhelming material expressions (such as buildings, roads, and so forth) that were mostly absent in Antarctica (as well as in other regions of the world where humans were also present).

In this chapter we reflect on the material dimension of the Antropocene in Antarctica. The questions we would like to pose are: What are the material entities and interactions we need to approach in order to gain a better understanding on the Anthropocene in the region? What are the underlying definitions of the material world that are brought into play, intentionally or not, by this discussion? What are these definitions including or leaving out? The chapter is divided into two different, but interrelated sections. In Sect. 12.2, we describe our initial approaches to the subject, when we were still constrained by an orthodox understanding of the material world. In Sect. 12.3, we critically reflect on our previous work and explore new possibilities for analysis, considering a challenging definition of the material world, bodily experience, and the interconnectedness of the webs of life. It is relevant to stress that the impressions presented in the chapter are not finished. They are just a moment in a constant flow of ideas, perceptions, and emotions.

12.2 First Thoughts on the Material Dimension of the Anthropocene in Antarctica

When we first decided to discuss the material dimension of the Anthropocene in Antarctica, we thought it was convenient to go through the trajectory and results of our own research project. When we started working on the South Shetland Islands, one of the first things we noticed was that the opposition between "nature" and "culture," and the importance given to "nature" in the face of "culture," were central to scientific work in the continent. While research projects in natural sciences were dominant, those in humanities and social sciences were a minority. The lack of communication between these fields only increased the gap. In the 1990s, a group of geologists working on Livingston Island (South Shetlands) found a series of "old artifacts" in a cave. They decided to call us: these remains were "cultural" evidence. Even though these things were thought to be part of a shelter improvised by castaways, we found out that they were part of a sealers' camp (Muñoz 1996; Zarankin and Senatore 1999, 2005, 2007). The South Shetland Islands were the primary focus for sealing in Antarctica during the nineteenth century. At that time, captains landed small gangs of workers on the shores to hunt seals and elephant seals. Skins and oil were later sold in the capitalist world market (Fanning 1833; Stackpole 1955; Silva 1985; Headland 1989; Berguño 1993a, b; Maddison 2014).

The road was not easy for the research project. Among other things, sealers' camps were not impressive. In 2001, the authorities of the Argentinean Antarctic Institute told us, Why do you want to pursue archaeology in Antarctica? There are no pyramids there (understanding that, unlike sealers' camps, the monumentality of pyramids was a material expression worth studying). Despite all the obstacles and challenges we faced, as time went by we managed to create an international project of historical archaeology in Antarctica. At present, the "Landscapes in White" project includes researchers from Brazil, Argentina, Chile, the United States, and Australia (such as Andrés Zarankin, Melisa A. Salerno, Rubén Stehberg, Adrian Howkins and Mike Pearson). For years, what we looked for on the South Shetland Islands was what we were once taught to find as archaeologists: mainly "artifacts" and "structures" whose distribution and abundance defined the archaeological presence of historical sites. We had naturalized the idea that human interactions with the world took solid, concrete, finished forms. Without these traces, we felt lost.

Following these guidelines, only on Byers Peninsula (on the West coast of Livingston Island), did fieldwork made it possible to detect 27 archaeological sites corresponding to nineteenth-century sealers' camps (Zarankin and Senatore 2007). We decided to focus attention on these places. Historical documents gave little information on sealers' lives in Antarctica, but archaeological evidence seemed to be enlightening. At first, consideration of artifacts and structures gave us a chance to analyze different sets of social practices (Senatore and Zarankin 1997, 1999; Zarankin and Senatore 1999, 2005). We learned that sealers built their shelters mainly using local materials such as stones and skins (Fig. 12.1); that they usually ate the same animals they killed for the global market, including seals and elephant

Fig. 12.1 Map of South Shetlands' archaeological sites

seals; that they had to do their best to keep themselves warm and continue wearing their old clothes and shoes in a harsh environment; that they spent their leisure hours playing board games, smoking tobacco, or drinking alcohol; etc. As we will show later, we did not pay too much attention to some other issues. In short, we felt we did not have enough "material evidence" to study them.

Even though fieldwork focused on nineteenth-century sealers' camps, the research project also looked for traces of human presence during the twentieth and twenty-first centuries (Zarankin and Senatore 2007). Leaving aside different areas showing remains brought ashore by sea currents, we only identified a few isolated artifacts connected with scientific activities; for instance, the remains of an old sleigh left by researchers. In the 1950s, the Antarctic Treaty (1959) prohibited the development of military exercises in the continent. Antarctica was thus transformed into an international territory connected to scientific and cooperative research. In the 1990s, the Madrid Protocol (1991) set specific principles to regulate human activity in the region. These standards urged scientists to remove every single item they had brought with them for fieldwork. The intention was that visitors could act as "spectators of nature" (reducing "human disturbance" everything they could) (Fig. 12.2).

Considering our previous work, we argued that the distinctive features of the Anthropocene in Antarctica did not rest on the "wilderness" of the region or in its return to a certain "state of wilderness." For us, these distinctive features were nothing but a product of the historical ways in which humans interacted with the material world. Over the course of time, people moved from uncontrolled exploitation of animal resources, to scientific research and a persistent concern for environmental

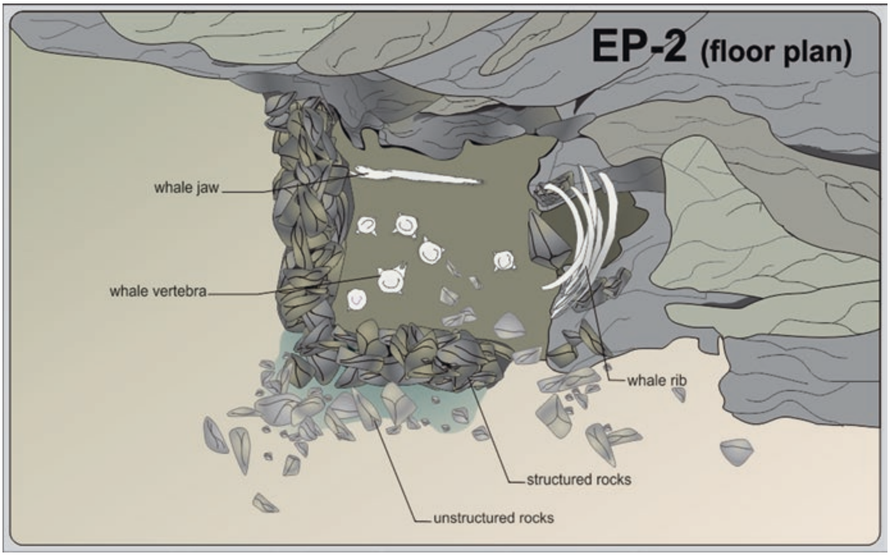

Fig. 12.2 Layout drawing of Punta Elefante sealers' camp

conservation (Zarankin and Salerno 2014). In the nineteenth century, sealers left humble but visible material traces of their presence. In the twentieth and twenty-first centuries, scientists made an effort to delete or reduce their own. As archaeologists, we cautioned that these circumstances should not be confused with an absence of human interaction with Antarctica. On the contrary, the Anthropocene intensified in Antarctica taking particular forms.

As the term was frequently used, at least for referring to the case of Antarctica, we claimed that the notion of the Anthropocene seemed to equate the history of human interactions with the environment with increasing physical impact on the latter and the apparent lack or the decrease in the abundance of these traces with "nature" (Zarankin and Salerno 2014). We argued that excluding other variables from the analysis ended up creating a generalizing model which masked the multiple relationships that humans established with the world (Zarankin and Salerno 2014). But if other scholars had their own fixed categories to "measure" the Anthropocene, did not we also have our own? Theirs seemed to be more impressive material expressions, while ours included "small findings."

12.3 Was That It? Rethinking the Material Dimension of the Anthropocene in Antarctica

Our own categories left a whole series of material entities and relationships aside. This guess led us to continue our research. At some point, we started wondering: Do we really need to limit the archaeological study of the Anhropocene in Antarctica to the analysis of artifacts and structures? What about animals, sea, ice, wind, shores, cliffs, sunlight, people's bodies, among others? Were not they material? Were they "too natural" to be considered by us? Sealers' experiences in Antarctica, as well as our own, pointed to multiple entities and relationships which were impossible to grasp through the orthodox categories of archaeology. However, all of these entities and relationships were and still are important to people visiting the continent (even though in different forms). In order to deepen the understanding on the material dimension of the Anthropocene in Antarctica, we started feeling that it was necessary to discuss our own assumptions on the material world, and resort to broader and more fluid definitions.

As a matter of fact, a couple of years before our first approach to the Anthropocene, we started exploring—mainly from a phenomenological perspective—the possibility of considering the material dimension of the body, including the emotional, synaesthesic and kinesthetic experience of the flesh (Fig. 12.3). This perspective also allowed us to discuss the bodily and practical knowledge of the world and the dynamic and reversible relationships between subjects and objects (Salerno 2006, 2007, 2009, 2011; Salerno and Zarankin 2014; Cruz 2014). As time went by, we also started considering some points developed by Tim Ingold (2000, 2006, 2007a, b, 2011) on the relevance of materials for archaeological analysis. From this standpoint, materials are conceived as constituents of an environment, where they do not represent fixed entities (defined by the imposition of form upon inert matter), but processual and relational ones. People's engagement with the material world implies practical experience, and it is in the webs of life where our bodies and other entities flow, mix and change.

In the next paragraphs, we present different lines of inquiry we are currently exploring to rethink the dynamics of the Anthropocene in Antarctica—its webs and fluxes along time. Considering this, we refer to nineteenth-century sealers' engagement with the material world, as well as our own.

Fig. 12.3 Archaeologist removing all remains of their camp before leaving the region

12.3.1 Sealers

To a certain extent, we have the impression that when we limited ourselves to the study of artifacts and structures from sealers' camps, we forgot we were dealing with sealers. As Stackpole (1955), a historian of the sealing industry once said, sealers were a mixture of sailors and hunters. Behind these simple words, a complex web of humans and non-human entities emerges (Ingold 2011). Different regions of the world, vessels, water, air, animals, and people were all part of a dynamic, moving, and interconnected universe.

For years, we did not venture beyond the South Shetland Islands. Even though we accepted that sealers spent the summer season there, and that sealing was a world industry, we decided to remain on the islands. Sites were our primary unit of analysis. We were simply fixed. The "sedentarism of our own archaeological project" (*sensu* Salerno and Marschoff 2015) prevented us from considering sealers' mobility. However, most of the sealing companies operating on the South Shetlands were from the United States or the United Kingdom; the crew of the vessels frequently included men from different nationalities and of different ethnicities; and sealing voyages to the region also entailed visits to other hunting grounds, commercial ports, and so on (Landis 2001; Headland 1989, 2009; Mills 2003; Clancy 2014). At present, we believe that to understand the particular features of the Anthropocene in Antarctica, we should take into account the pace of the Anthropocene in other places, the material fluxes of people and things between these contexts, as well as the material impact of the seasonal occupation of the islands.

It is also worth mentioning that sealers spent most of their voyages on board a vessel—on a moving entity that took them from one place to the other. Water and air were their elements. But water and air were not something we were used to approaching. They had a fluid materiality. However, they were important to sealers just as they were to all sailors. When a man first entered the trade, old sailors used to say he had to get his "sea-legs." He had to overcome sea-sickness, a result of the misbalance between the movement of his body and the vessel. He also had to learn how to sail the ship. Opening and closing the sails was necessary to get the most of the wind, but also to protect the vessel from storms and gales. A man also had to learn how to synchronize his movements with the movements of the rest of the crew. Sailing created an orchestrated dance of bodies and things (Salerno 2011, 2014).

Sealers sailed the seas around the South Shetland Islands while they were free from the ice sheet. They had to approach the coasts with the practical knowledge of sailors, considering the sea currents, the entrances and reentrances of the sea, and the places where it was safe to drop anchor. As we tried to point out, sea, air, and vessels were an integral part of the relationship between sealers and the world. As approaching the Anthropocene in Antarctica involves discussing the human interaction with the region, we believe it is relevant not to underestimate these elements. Therefore, our research project is currently working with maritime and underwater archaeologists interested in the subject, and considering future work with oceanographers and climatologists.

It is surprising that we have approached sealers for years, but have paid little attention to hunting and processing. When we excavated sealers' camps, we were able to recover little "evidence" on the subject. We only found a small number of tools, including a sealing club, a knife, and some wooden pegs. Hunting activities were supposed to take place near the shore, where the sea eventually wiped away all of its traces. In general, we only referred to animals when we discussed sealers' eating practices. How people could have related to animals beyond that was not even considered.

Sealers did not only look for good anchorage points, but also for animal colonies. When sealers first arrived on the South Shetland Islands, the animals were not used to human presence. It was easy to kill them. A single vessel could load thousands of skins and tons of oil in a single visit. However, as time went by, colonies not only decreased in size, but animals also changed their habits. Some seals settled in other locations and became afraid of humans, being increasingly difficult to hunt. The study of the historical and material dimension of the Anthropocene in Antarctica should not lose sight of these circumstances.

Killing and processing the animals required specific skills. Sealers had to approach them in silence, in a sort of row to prevent them from escaping (Satackpole 1955). They used clubs and in some cases firearms to kill them. The slaughter made quite an impression on those who entered the trade. Transforming the fat and the skin of the animals into oil and furs was not simple. It was necessary for sealers to be acquainted with the changing properties of these specific materials.

Sealers had to learn how to handle the knives and separate the skin and the fat from the rest of the body. The fat was melted in try-kettles which were lighted in small structures near the shelters. Meanwhile, the skins were salted or dried in the sun. One of sealers' main challenges was preventing the skins from rotting. If everything went right, the oil produced on the South Shetland Islands could be used for lighting the houses of different regions of the world, while the skins could be used in the production of clothing. In our view, the archaeological study of the Anthropocene in Antarctica should consider the relationship of humans with animals, including the practical understanding of their material properties.

12.3.2 Archaeologists

The sealers' experience was just a moment in the flux of time, space, and materials defining the Anthropocene in Antarctica. For years, we did not take into account our own experience on the South Shetland Islands. It was only part of our anecdotes, of a series of marginal notes in our field diaries. However, as time went by, we realized our own experience was important for understanding how scientists related to Antarctica and discussing how archaeologists approached the material world of the region (Fig. 12.3). At present, we believe it is relevant to include ourselves in the webs of life defining the Anthropocene in the continent (Salerno 2011, 2015a, b; Zarankin and Senatore 2012; Zarankin 2015; Cruz 2014; Salerno and Zarankin 2014).

Fig. 12.4 Archaeologists using their own body to interpret the conditions of existence in sealers' shelters

One of the things we learned during fieldwork was the particular experience of being in a place like Antarctica. For some of us, the journey to the South Shetlands represented a rite of passage. It often takes between 10 and 15 days to arrive at the base-camp; and the journey includes the use of military aircrafts, boats, ships, and helicopters (Fig. 12.4). In some way, we were isolated from the universe we know. We needed to learn how to move in the fog, how to walk on the ice, how to sleep, and how to organize our time in a place where the sun never sets. We needed to reinforce our relationship with animals, strong winds, snow, and the sea.

Working in the South Shetlands is not easy. We face situations that most archaeologists do not even imagine. We often arrive at the archaeological sites and find a couple of sea-elephants resting inside sealers' shelters. We have dozens of penguins observing us while we dig. Over the years, we had to learn how to excavate the permafrost and how to collect archaeological remains (Fig. 12.5). We also had to learn how materials change from the moment we found them, until we analyze them in the laboratory. Materials change their color, sizes, textures, and shapes (Salerno et al. 2007; Figueiredo Jr. et al. 2013). They are not finished objects, but mutable entities in the flow of interactions that also involved sealers and ourselves (Fig. 12.6).

After 20 years, we can say that we have gained the bodily experience of being in Antarctica, living in a base-camp, and excavating a sealers' shelter. This is something more than a static picture. We can feel it in the flesh. We have learned to follow the materials. We have let our bodies guide us. We have come across practical meanings that help us establish a particular relationship with the world we study. Even

Fig. 12.5 The voyage to Antarctica involves several means of transport

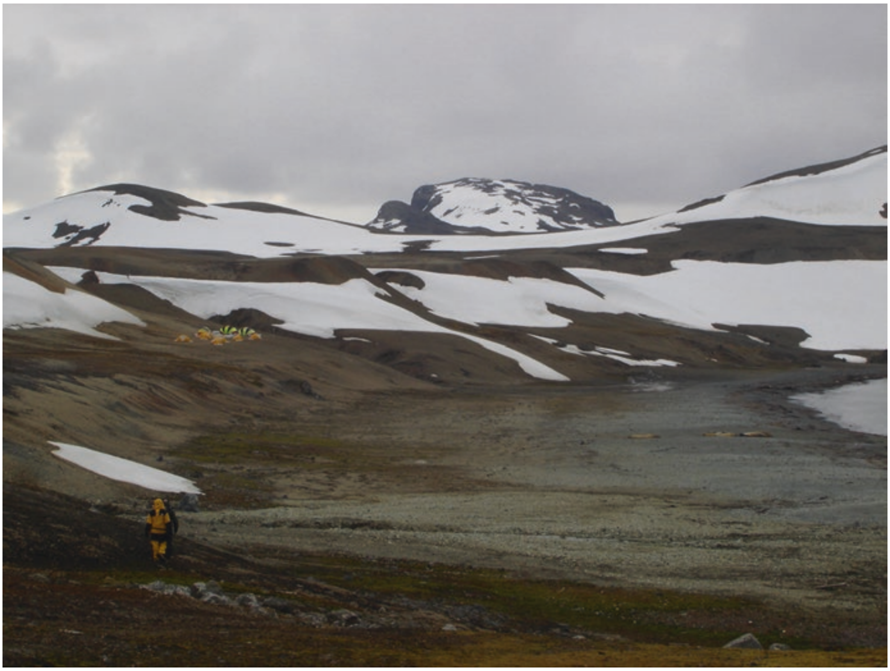

Fig. 12.6 Archaeologists must become acquainted with the dynamics of Antarctica in order to work there

though we follow the guidelines of environmentalist protection, and try to minimize possible disturbance on the region, our participation in the webs of life in Antarctica is undeniable.

12.4 Final Words

We need to continue exploring the multiple relationships that define the Anthropocene in Antarctica. Our orthodox education made us miss a richer and more complex universe. Archaeology has been traditionally trapped in narrow perspectives focused on artifacts, rigid divisions of the world, and occularcentric understandings excluding other aspects of our bodily engagement with the material reality. A web perspective is interesting to overcome these limitations, to call back other materials and entities frequently excluded from archaeological interest. If we let them guide us, following their flows and movements, maybe we can gain a better understanding of the life processes where humans and non-humans relate.

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References

Berguño, J. (1993a). Las Shetland del Sur: El ciclo lobero. Primera parte. *Boletín Antártico Chileno, 12*, 5–13.

Berguño, J. (1993b). Las Shetland del Sur: El ciclo lobero. Segunda parte. *Boletín Antártico Chileno, 12*, 2–9.

Clancy, R., Manning, J., & Brolsma, H. (2014). *Mapping Antarctica. A five hundred year record of discovery*. New York: Springer.

Cruz, M. J. (2014). *Incorporando comidas e contextos. A alimentação e o Corpo nos Grupos Foqueiros nas Shetland do Sul (Antártica, Século XIX)*. Master's diss., Universidade Federal de Minas Gerais.

Edgeworth, M. (2014). Archaeology of the Anthropocene. *Journal of Contemporary Archaeology, 1*(1), 73–132.

Ellis, E., & Ramankutty, N. (2008). Putting people in the map: Anthropogenic biomes of the world. *Frontiers in Ecology and the Environment, 6*(8), 439–447 https://doi.org/10.1890/070062.

Erlandson, J. M., & Braje, T. J. (2013). Archeology and the Anthropocene. *Anthropocene, 4*, 1–7 Elsevier. https://doi.org/10.1016/j.ancene.2014.05.003.

Fanning, E. (1833). *Voyages round the world*. New York: Connins & Hannay.

Figuereido Jr, J., Oliveira, J. A. D. S., De Souza, G. S. M., Froner, Y., Souza, L., & Zarankin, A. (2013). Characterization of corrosion products on metals excavated from sealers' occupation in Antarctica in the eighteenth and nineteenth centuries. *Studies in Conservation. International*

Institute for Conservation of Historic and Artistic Works. http://www.maneyonline.com/doi/abs/10.1179/2047058414Y.0000000138. Access 10/12/2014.

Headland, R. (1989). *Chronological list of Antarctic expeditions and related historical events*. Cambridge, UK: Cambridge University Press Studies in Polar Research.

Headland, R. (2009). *A chronology of Antarctic exploration. A synopsis of events and activities from the earliest times until the international polar years 2007–2009*. London: Bernard Quaritch Limited.

Ingold, T. (2000). *The perception of the environment: Essays in livelihood, dwelling and skill*. London: Routledge.

Ingold, T. (2006). Rethinking the animate, re-animating thought. *Ethnos, 71*(1), 9–20.

Ingold, T. (2007a). Material against materiality. *Archaeological Dialogues, 14*(1), 1–16.

Ingold, T. (2007b). Writing texts, reading materials. A response to my critics. *Archaeological Dialogues, 14*(1), 31–38.

Ingold, T. (2011). *Being alive: Essays on movement, knowledge and description*. London: Routledge.

Landis, M. (2001). *Antarctica. Exploring the extreme—400 years of adventure*. Chicago: Chicago Reviwe Press Inc..

Madisson, B. (2014). *Class and colonialism in Antarctic exploration, 1750–1920*. London: Pickering and Chatto Publishers.

Madrid Protocol on environmental protection to the Antarctic Treaty. (1991). Secretariat of the Antarctic Treaty. http://www.ats.aq/documents/recatt/Att006_e.pdf Accessed 12/10/2014.

McCloskey, M., & Spalding, H. (1989). A Reconossaince level inventory of the amount of wilderness remaining in the world. *Ambio, 18*(4), 221–227.

Mills, W. (2003). *Exploring polar frontiers. A historical encyclopedia*. Santa Barbara: ABC-CLIO.

Muñoz, S. (1996). Arqueofaunas de la Isla Livingston, Shetland del Sur. Un estudio exploratorio de los restos de mamíferos recuperados en la península Byers. *Archaeofauna, 9*, 39–57.

Salerno, M. (2006). *Arqueología de la indumentaria: Prácticas e identidad en los confines del mundo moderno*. Buenos Aires: Del Tridente.

Salerno, M. (2007). "Identidades extremas": Moda, vestido e identidad en los confines de la sociedad moderna (Antártida, siglo XIX). *Arqueología, 13*, 185–211.

Salerno, M. (2009). Zapatos Rotos: Una aproximación al calzado en arqueología histórica. In *VI Congreso Argentino de Americanistas*. Buenos Aires: Sociedad Argentina de Americanistas. Dunken.

Salerno, M. (2011). *Persona y cuerpo-vestido en la modernidad: Un enfoque arqueológico*. Phd diss. in archaeology. Facultad de Filosofía y Letras, Universidad de Buenos Aires.

Salerno, M. (2015a). Sealers were not born but made. Sensory-motor habits, subjectivities, and nineteenth-century voyages to the South Shetlands. In J. Pellini, A. Zarankin, & M. Salerno (Eds.), *Coming to senses. Topics in sensory archaeology* (pp. 77–104). Newcastle Upon Tyne: Cambridge University Press.

Salerno, M. (2015b). Persona y cuerpo-vestido en la modernidad. Los loberos-balleneros de la industria capitalista del siglo XIX. *Vestígios. Revista Latino-Americana de Arqueología Histórica, 9*(1), 113–153. Argumentum/Universidade Federal de Minas Gerais, Belo Horizonte.

Salerno, M., & Marschoff, M. (2015). En el camino: Misioneros, recorridos y paisajes (Esteco, s. XVI–XVII; Tierra del Fuego, s. XIX–XX). In *Anales de la II Semana de Arqueología*. Campinas: Universidad Estadual de Campinas In press.

Salerno, M., & Zarankin, A. (2014). En busca de las experiencias perdidas. Arqueología del encuentro entre los loberos y las Islas Shetland del Sur (Antártida, siglo XIX). *Vestígios. Revista Latino-Americana de Arqueologia Histórica, 8*(1), 131–157.

Salerno, M., Rodríguez, M., & Valladares, I. (2007). Memorias materiales: Conservación y protección de un pasado "sin historia". In C. Vázquez & O. Palacios (Eds.), *Patrimonio cultural: La gestión, el arte, la arqueología y las ciencias exactas aplicadas* (pp. 235–244). Buenos Aires: Eudeba.

Senatore, M. X., & Zarankin, A. (1997). Arqueología histórica en Antártida. Avances en la investigación. In *Actas del II Congreso Argentino de Americanistas* (Vol. 2, pp. 585–603). Buenos Aires: Sociedad Argentina de Americanistas.

Senatore, M. X., & Zarankin, A. (1999). Arqueología histórica y expansión capitalista. Prácticas cotidianas y grupos operarios en la Península Byers, Isla Livingston, Shetland del Sur. In A. Zarankin & F. Acuto (Eds.), *Sed non satiata. Teoría social en la arqueología latinoamericana* (pp. 171–188). Buenos Aires: Del Tridente.

Silva, H. (1985). La pesca y caza de lobos y anfibios. La real compañía marítima de Pesca en Deseado (1970-1807). In *Historia marítima argentina* (Vol. 4, pp. 507–529). Armada de la República Argentina, Buenos Aires: Departamento de Estudios Históricos Navales.

Solli, B., Burstrm, M., Domanska, E., Edgeworth, M., González-Ruibal, A., Holtorf, C., Lucas, G., Oestigaard, T., Smith, L., & Witmore, C. (2011). Some reflections on heritage and archaeology in the Anthropocene. *Norwegian Archaeological Review, 44*(1), 40–88.

Stackpole, E. (1955). *The voyages of the Huron and the huntress: The American sealers and the discovery of the continent of Antarctica*. Mystic: Marine Historical Association.

The Antarctic Treaty. Washington DC. (1959). Secretariat of the Antarctic Treaty. http://www.ats.aq/documents/ats/treaty_original.pdf. Accessed 12/11/2014.

Zarankin, A., & Salerno, M. (2014). The wild continent. Some discussions on the Anthropocene in Antarctica. *Journal of Contemporary Archaeology, 1*(1), 114–118.

Zarankin, A., & Senatore, M. X. (1999). “Estrategias y tácticas” en el proceso de ocupación de la Antártida –siglo XIX. In *Desde el país de los gigantes. Perspectivas arqueológicas en patagonia* (Vol. 1, pp. 315–327). Río Gallegos: Universidad Nacional de la Patagonia Austral.

Zarankin, A., & Senatore, M. X. (2005). Archaeology in Antarctica, 19th century capitalism expansion strategies. *International Journal of Historical Archaeology, 9*(1), 43–56.

Zarankin, A., & Senatore, M. X. (2007). *Historias de un Pasado en Blanco*. Argumentum, Belo Horizonte: Arqueologia Historica Antartica.

Zarankin, A. & Senatore, M. X. (2012). Storytelling, Big Fish e arqueologia. Repensado o caso de Antartida. In W. Morales & F. Moi (Eds.), *Tempos Ancestrais* (pp. 281–301). SaoPaulo: Annablumme.

Zarankin, A. (2015). Archaeology of a tear: Delusions in a tent in a stormy day in Antarctica”. In J. Pellini, A. Zarankin & M. Salerno (Eds.), *Coming to Senses: Topics in Sensory Archaeology* (pp. 11–20). Newcastle Upon Tyne: Cambridge Scholars Publishing.

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