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Choices in Common:
The Management of Common-pool Resources and the Evidence of Collective Action in Bronze Age Western Messenia

By

Rebekah Danielle McKay

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Classical Archaeology

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Kim Shelton, Chair
Professor Christine Hastorf
Professor Emily Mackil
Professor Nikolous Papazarkadas

Spring 2024

Abstract

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Professor Kim Shelton, Chair

This project explores choices pertaining to cooperative or noncooperative management strategies of forests and agricultural land in Bronze Age western Messenia, and how those strategies changed over time through coercive state action during the Mycenaean palatial period. When resource governance shifts from stake-holder to profit centers, sustainability measures may be deferred or subject to exogenous policies that promote extraction, commodification, and/or maximization over resource longevity and systems health. My objective is to a) determine if there were efforts made toward sustainability, cooperation, and longevity, b) detect response strategies to depletion or differential access, and c) couple the diachronic changes in plant communities with archaeologically invisible phenomena within the social and political landscape, revealing the institutions that drive policy and practices. Through an environmental reconstruction, I detected a deforestation event exclusive to the local pine population during the first 200 years of Mycenaean state formation, while deciduous oak populations remained healthy. This indicates that valuable oak wood was protected from over-extraction and deforestation by means of socially enforced procurement rules, and the pine absorbed the costs of growing populations and increased industrial outputs despite its overall inferiority. While initially these rules were likely community enforced, the consumption behavior of the palace at its height of power asserts that they either co-opted the administration of the procurement institutions in order to secure their own material gain and reinforce palatial authority. A parallel move toward privatizing key resources is observable in the administrative records dedicated to transactions related to private and communal landholdings. Here, private property was set apart from the common-pool and, I argue, became subject to tenure-bound service requirements in the form of forced redistribution in return for the state's acknowledgment of property boundaries and sole control over surplus. In both strata, the privatization of arable land/oak resources both accommodated the threat of scarcity under conditions of exponential demographic growth and consolidated sources of social and economic capital. Ultimately, the state inserted itself into various fields of power; they were

appropriating the measures taken by communities to stymie scarcity while simultaneously *creating* scarcity through intensive extraction, disrupting community autonomy and threats to their own authority, and crafting statist capital with the spoliated institutions of a subjugated populace.

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I. INTRODUCTION

The Bronze Age on mainland Greece is a period in prehistory that is at once rich in archaeological and documentary evidence *and* beset with inscrutable mystery. We have testimony of the minutiae of state bureaucracy, palatial administrative centers, and a rich mortuary landscape. Yet we still debate the nature of basic power structures, the flow of resources and commodities, spheres of influence over behavior, wealth, and community autonomy, and the state formation processes. The data form a constellation of semi-isolated phenomena that, packaged in different ways and imposed over different interpretive scaffolding, render different profiles of the state, the economy, and subsistence strategies. In this project I address these persistent questions from an ecological angle: common-pool resource procurement and human-environment engagements in the Pylian Kingdom. To this end, I examine the interface between the institutional environment in Bronze Age Messenia and their common-pool resources (CPRs), whether formalized systems of rules and penalties related to resource procurement were instituted, and whether demographic, political, or economic conditions influenced institutional change. Finally, I consider how CPR management institutions intersected with palatial power structures in the period of state formation. My approach is to use an integrated, comprehensive methodology, aligning long term trends in the vegetation history with demographic data, resource demand modeling, and the practical realities of agricultural strategies. In the documentary evidence I find extractive state policies and pair them with contemporaneous and ethnographic analogues, and ultimately triangulate archaeologically invisible phenomena and reveal the social forces that drive policy and practices.

This project explores choices pertaining to cooperative or noncooperative management strategies of forests and agricultural land in Bronze Age western Messenia, and how those strategies changed over time through coercive state action during the Mycenaean palatial period. This temporal scope is key to answering the primary questions of whether and how collective actions were taken to mitigate overexploitation of a limited resource, since our ability to observe conditions of cooperative consensus is dependent upon their being insulated from the prescriptions of exogenous, profit-seeking policy makers. Without the coercive governance of the commons, the cooperation of the users and their social dynamics are both more visible and more likely required. These were the conditions of Middle Helladic (2200 - 1700 BCE) Messenia, whose rising, jagged landscape was peppered with non-consolidated hamlets of perhaps 20 families each. Here cultural cohesion can be inferred from conventions of style (mortuary practice, ceramics, technology), but prior to the advent of the Mycenaean state there is no evidence for political unity or prevailing state policy. As such, it can be assumed that local, group-specific attitudes about correct behavior were not relegated or eclipsed by the needs of the ruling authority and are thus detectable.

In contrast to MH Messenia, which remained relatively decentralized, the transition from users being beholden to some self-governing body to their being beholden to the palatial polity during the Late Helladic period may show contrast or continuity with respect to these earlier strategies. The consolidation of wealth and the access to international trade potentially curbed or overrode

conventional appropriation practices. When resource governance shifts from stake-holder to profit centers, sustainability measures may be deferred or subject to exogenous policies that promote extraction, commodification, and/or maximization over resource longevity and systems health. In this later period Pylian resource stewardship may have appropriated pre-state CPR management institutions, or co-opted them in order to serve the interests of the state.

The narrow geographical purview of this project is designed as a pilot study, whereby the abundant published data (palynological, geomorphological, climatological, survey, and documentary) from Messenia bring into focus a complete, if regional, paradigm. It is at the intersection between population and geography, climate, and vegetation, that the stories of human and plant communities are recorded in Greek prehistory. The outcomes of changing climatic conditions, adaptations to growing populations, and the silhouettes of systems of values are folded into the landscape. Today these traces are faint, and consequently my approach to understanding CPR engagements during the Bronze Age is necessarily interdisciplinary. I pair long-term ecological and climate data in order to discern human interventions, both sustainable and unsustainable. I then develop wood-use (fuel and timber) models and analyze settlement patterns in order to determine more precisely the increased pressure exerted on the landscape. Finally, I overlay these ecological conditions with a new reading of the complex land organization system recorded in the Linear B documents from Pylos, which bring to light how modes of resource use, management, and sharing practices inflected the social landscape of the users. My objective is to a) determine if there were efforts made toward sustainability, cooperation, and longevity, b) detect response strategies to depletion or differential access, and c) couple the diachronic changes in plant communities with archaeologically invisible phenomena within the social and political landscape, revealing the institutions that drive policy and practices.

To define my study region, I use the "pollen catchment area" (PCA) (Figure 1.2), the area that sources the pollen rain collected in core samples. By reassessing the existing pollen record, tracking the diachronic changes in atmospheric moisture as indicated by nearby speleothem formations, and mapping this data onto regional settlement patterns in the Pylos region, I detected three deforestation events that took place between 6000 BCE and 1200 BCE. Two of these were anthropogenic, and the last one resulted in the permanent annihilation of local pine populations during the first 200 years of Mycenaean state formation. This final deforestation event was exclusive to the previously abundant pine populations, and as they slowly declined between ~1700 and ~1400 BCE, deciduous oak populations remained healthy. This indicates that valuable oak wood was protected from over-extraction and deforestation by means of socially enforced procurement rules. Even hundreds of years before the appearance of the palace, fuel and timber appropriation behaviors were controlled. The pine absorbed the costs of growing populations despite its overall inferiority, while deciduous oak was spared from the scale of extraction that eliminated pine stocks. Moreover, this continued to be true even *after* the pine was depleted. While initially these rules were likely community enforced, the consumption behavior of the palace at its height of power asserts that they either co-opted the administration of the procurement institutions by making a special exemption for themselves or by subverting them altogether in order to secure their own material gain and reinforce palatial authority.

One may call to mind the sacred groves in the Greek historical period, which were subject to specific regulations that protected their integrity via divine associations. In the Bronze Age, despite

increased oak timber and fuel demand, these populations were set apart from the common-pool. In this context, we need not distinguish between "sacred" and "private," since, regardless of the proprietor, access rights were granted to those in service of the state. A parallel move toward privatizing key resources is observable in the administrative records, written in Greek with the Linear B script ca. 1200 BCE, dedicated to transactions related to private and communal landholdings. This tablet series is a keystone for understanding property rights in the Bronze Age, and yet the conventional reading is afflicted with critical epistemic failures. In my re-reading of the E-series documents, I challenge the foundational interpretive premise that the standard *grain* measurement recorded in each entry is, in fact, a proxy for *land* measurement and that the transactions recorded in this series are leases of land. Rather, based on my integrative approach, I argue that the subject of the transaction, the *o-na-to*,[1] is not a leased parcel but a "benefit" that *derived* from a landholding, private or communal, and was composed of agricultural produce and dispensed by landholders to individuals who worked in service of the sanctuary. Here, private land parcels were constructed to sustain a growing population under the highly extractive conditions of palatial hegemony and would have coexisted with the traditional communal land arrangements. Private property was set apart from the common-pool and, I argue, became subject to tenure-bound service requirements in the form of forced redistribution in return for the state's acknowledgment of property



Figure 1.1 Map of Peloponnese, Messenia in box.

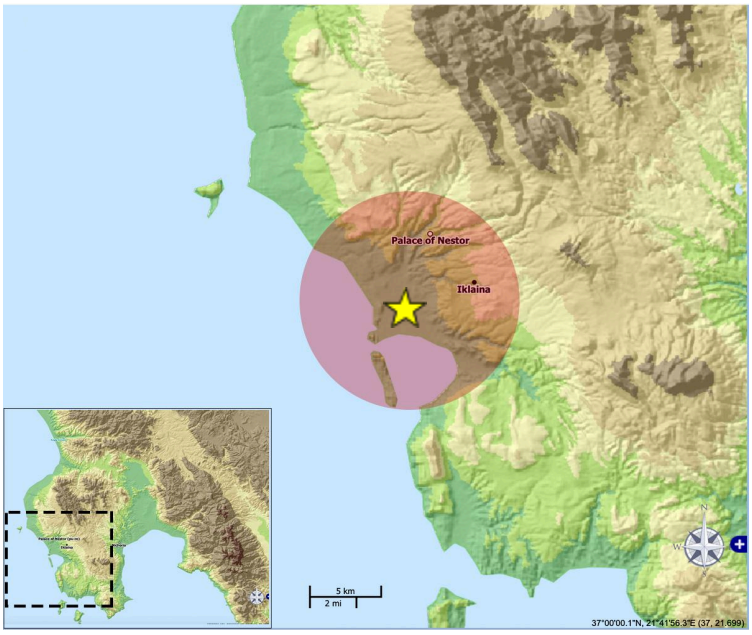


Figure 1.2 Osmanaga Lagoon pollen catchment area (pink circle); area from which the cores were extracted marked with yellow star.

[1] Related to ὀνίνημι "aid, benefit" (Liddell et al.,, 1996; abbrev. LSJ).

boundaries and sole control over surplus. Once again the state (~1400-1200 BCE) exerted enough extractive pressure to interfere with traditional cooperative strategies and compel privatization under threat of resource scarcity.

In both strata, the privatization of arable land/oak resources both accommodated the threat of scarcity under conditions of exponential demographic growth and consolidated sources of social and economic capital. Ultimately, the state inserted itself into various fields of power; they were appropriating the measures taken by communities to stymie scarcity while simultaneously *creating* scarcity through intensive extraction, disrupting community autonomy and threats to their own authority, and crafting statist capital with the spoliated institutions of a subjugated populace.

This chapter of my dissertation engages with scholarly discourse related to ancient farming practices, forestry, and New Institutional Economics, which serve as foundations for my later analysis. Here I also provide a detailed overview of my methodology. The second chapter outlines the geographical scope of the project and presents the formal aspects of the geography, topography, demography, and ecology of the area of study, both now and in the past. Paleoclimatic data is particularly important in reconstructing their environmental conditions in the Bronze Age, since, superimposed over the vegetation history, it reveals instances of human interference insofar as it excludes rainfall variability as the source of change. The combination of these data ultimately articulates the human-paleoecology and the interventions that mark individual and collective choice.

The third chapter focuses on human engagements with forest resources during the Bronze Age and how they are shaped by perceptions of value and scarcity. Through a survey of more recent (17th c. to present) resource-use policies and ethnographic studies, I define, both ecologically and cognitively, three types of forest relationships: the crop forest, the moral forest, and the rural forest. With the dimensions of these relationships outlined, I then develop a forest resource demand model that is specific to the area of study, and I establish which relationship is manifest according to the data.

The analysis of these two categories of data take the "bottom up" view of CPR exploitation in Messenia, and they also reveal some cultural implications, namely the evidence for, or absence of, CPR management institutions. Once these conditions have been established, however, looking at the documentary evidence from the palatial center offers other benefits. Under the palatial governance, effective practices in CPR management and the cultural norms that they begot would certainly be a concern in the administration of the territory, even if they are reversed or ignored. In the fourth chapter I consider the Pylos E-series tablets (in combination with other auxiliary series) in order to decipher land-tenure arrangements and ownership structures. The fifth and final chapter is dedicated to tracking these modes of organizing and governing the management of these essential resources into the historical period. I synthesize the attitudes towards and ecological outcomes of common-pool resource management discovered in the previous four chapters.

1.1 **Patterns in Ancient Resource Engagement**

The use and effective management of common-pool resources (CPRs) in the ancient world is a complex social and economic dilemma that is acutely relevant to our current ecological and climate circumstances. Patterns of resource use are the artifacts of community needs, and perceptions of

*over*use are culturally bound, limited and defined by a mutually understood hierarchy of needs. The choice to intervene or not, to use sustainably or not, is an expression of community values and is particularly pronounced in areas where natural assets, such as arable land and forests, are limited. By definition, the commons are exclusively local and limited, and since their exploitation determines the survival of the local population, their long-term yield requires collective action. These resources are "neither public nor private [but] geographically confined" and used according to systems of access rights.[2] They are categorically local and limited, and they are fundamentally and necessarily subtractable. Resource "users" withdraw from the common-pool and use or consume those units for a) themselves, as a family would collect wood to fuel their hearth fire, b) for economic gain, such as a fisherman selling their catch, or c) as inputs into production processes, such as irrigating fields to grow wheat, or fueling ceramic kilns.

Following the publication of Garrett Hardin's seminal 1968 article on the "tragedy of the commons," there has been a prevailing assumption that the exploitation of CPRs is necessarily dictated by an exclusive interest in personal gain, inevitably resulting in over-use and the ultimate destruction of the resource pool.[3] The classic example, which Hardin deployed in order to illustrate the inevitability of the tragedy, is that of the pasture and the rational herder. Here "each herder is motivated to add more and more animals [to their flock] because [they] receive the *direct* benefit of [their] own animals... and bear only a *share* of the costs of overgrazing." Ultimately, the pasture becomes completely overgrazed and unusable. Hardin's thesis was nested within a larger comment on the insoluble problem of a growing global population within a world with finite resources, and foundational to the threats to the greater good is the axiom that a rational being will seek to maximize their *personal* gain if the negative consequences are *shared*. Thus, the tragedy is the aggregate of every negative externality borne by every individual's pursuit of personal gain.

Yet the default expectation of tragedy is propagated within the context of industrialization, capitalism, and the alienating gulf between individual user and governing body. In the modern industrial context overuse is inexpensive, and short-term gain is incentivized. Frenzied acquisition and profiteering precipitate noncooperative management strategies that without intervention undoubtedly result in tragedy. History is littered with examples of self-organized enforcement strategies that guarantee equal access and sustainability. More specifically, there have been numerous farmer-managed irrigation systems, communal forests and fisheries, and shared grazing and hunting territories. The particularities of these enforcement mechanisms are unique to the region, the resource, and the social organization of the population of users. It is certainly difficult to generalize about the ubiquity of successful CPR management strategies, and there remains a black box around the origins of these institutions, and the chronological limits of this project mean that specific institutional attributes and mechanisms for rule-making are impossible to observe.[4] As such, rather than tracking the sustainability/robustness of the *institutions*, I track the sustainability of the resource itself and infer shared values in turn. While we cannot access the operational-rules or even governing mechanisms of resource management institutions at this moment in early state formation, we may actually be privy to

[2] Dasgupta, 2005, p. 1611.

[3] Hardin, 1968.

[4] See Section 1.2.2 *New Approaches* for further discussion of institutional formalization.

institutional *formalization*, where social norms evolve into dynamic and explicit sets of rules. Based on a given ecological outcome, we can infer certain embedded orientations towards a resource *and* certain political conditions that begot formal institutions and institutional cooperation.

While numerous CPRs may have been scarce enough and important enough for survival to have met the requirement for collective action, I limit my consideration to two. First, the management of the forests would have been of grave concern, as timber was used for industrial processes, fuel, construction of domestic architecture, and the construction of transport vehicles (particularly ships). While this is a replenishable resource, the species with the greatest utility would have needed careful management in the pattern and timing of their felling in order to avoid their replacement with fast-growing but lesser-quality tree species or total deforestation. Second, I will look at the organization of agricultural land and the degree of effort put towards bringing uncultivated land under production. Depending on the ecology of an area, maximizing the arability of the land may have concentrated agricultural exploitation in a prescribed area and prevented the overexploitation of certain resources through accepted use restrictions. It also may index the prioritizing of a particular product over balanced resource stewardship and result in clearcutting or another form of resource pool depletion.

Arable land and healthy timber sources often cannot sustainably occupy the same spaces without management, and the development of agricultural properties is most often viewed as adversarial to the maintenance of healthy and productive forests.[5] Currently in the Brazilian Amazon burning large tracts of the forest for the sake of agriculture and livestock grazing–loosely sanctioned by the government–and illegal clearcutting for the exploitation of lumber and subterranean minerals–loosely restricted by the government–has led to the loss of 15-17% of the forest.[6] The unsustainable exploitation of this public resource, even through illegal channels, reflects the values of the state and local communities, since land appropriation and deforestation have been allowed to continue with impunity. In this case the absence of any use-restriction intervention has buoyed the economy and increased employment, reflecting the values of at least the governing body, but likely also the communities of users as well.

As each resource pool abuts and encroaches upon the precinct of another, individuals or groups can intervene in accordance with their values, or not. For example, a conflict over changing community values erupted in Oregon in the 1980s and 1990s over the logging of old growth forests. Here, as in Brazil, local economies were dependent upon the logging and milling of timber, and this attitude toward trees as crops is mirrored in the federal organization of the Forest Service, an agency of the U.S. Department of Agriculture. Extra-local beliefs about the value of these fast disappearing ecologies came into conflict with established modes of use, however, as environmental conservationists spurned the commodification of Oregon's forests.[7] These groups gained traction by litigating the sale of timber forests (by the Forest Service) to logging companies and appealing to the public with protests and spectacle. The friction between those holding these divergent beliefs was rooted in group-specific values, drawing environmental concerns into an already fracturing cultural climate. The "trees vs. people" paradigm is familiar and broadly applicable to many industries that no longer accord with

[5] Hughes & Thirgood 1982; Jahns, 1993; Turner & Greig, 1975.
[6] Barroso & Mello, 2021.
[7] Scott, 2020.

majority views about climate and conservation. In the end, these interventions were affirmed by the state, and the values of sustainable use and old growth preservation were ultimately reflected in state and federal legislation.

Yet despite the fact that the conservation of resources in the modern world is commonly undertaken through "fortress conservation," a practice that protects an environment from degradation through uncompromising exclusion (especially targeting cultivators), we ought not assume these behaviors can be retrojected. While forests and cultivable land cannot occupy the same spaces at the same time, this does not mean one *necessarily* holds priority over the other or that one is valueless. It is a familiar narrative that pairs the introduction/occupation of farmers in an area with the sudden loss of forest surface area and the ultimate erosion of productive topsoil. It is not uncommon in the Greek mainland for major erosional events to take place soon after the introduction of farming to an area, and it is often suggested that agricultural exploitation of the land is transformative and destabilizing. In other words, in the process of making a landscape arable, trees and shrubs are cleared in order to mitigate competition for moisture and nutrients, to concentrate edible produce in a given area, and to streamline harvest efforts. While appealing, this story is simplex and understates the value of forests to early occupants, including farmers. Not only would clear cutting en masse to make space for cultivable fields be highly costly, but it would work against the farmer's interests in several ways. First, it would hinder the population by sequestering fuel and timber sources to areas a great distance from the settlement nucleus and thus make fuel acquisition highly costly. It would also threaten a low effort source of animal fodder (forest litter). Finally, total forest removal would imply that the value of a bush or forest fallow would have been unknown or valueless to early farmers. In my estimation it is just as likely that the spatial arrangements of forest and farmland in prehistory would reflect balanced valuation, managed for subsistence in parallel.

At el-Hemmeh in central Jordan, for example, early-Holocene communities managed *pistacia* forests for both cultivation and wood-resources. Here, the dappled canopy of open stands were accompanied by low shrubs and grasses, which were occasionally burned for the sake of farming, while the timber and fuel were harvested from the trees sustainably, through coppicing and pollarding.[8] Forests have been managed from prehistory until the middle of the 20th c. in Europe, and the primary strategy for sustaining stands of high value trees is coppicing.[9] This method is grounded in the understanding that certain tree species that are less tolerant of canopy-crowding and encroachment are outcompeted (and ultimately overcome) by more shade tolerant species burgeoning from the understory. Oak is famously sensitive to disturbances in their exposure to sunlight (insolation) and, since coppicing efforts have ceased in Europe, has "lost [its] ability to successfully regenerate in many European woodlands"[10] due to competitive exclusion.[11] Yet oaks are high-value timber-producers, particularly for use in construction as well as fuel, and their exploitation sustains massive building projects, maritime transport, and the hot, long-burning temperatures of the industrial forges and kilns.

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[8] Asouti et al., 2015.

[9] Altman et al., 2013.

[10] Altman et al., 2013, p.2

[11] This is a phenomenon often termed "oak decline" (Altman et al., 2013, para. 3)

In a sense, statecraft is wood craft, and just like in the great hall of the Mycenaean megaron, the oak bore it aloft.

In managed forests the oak often served as what is called the "standard," the trees given license to grow to their full height and whose scattered canopy is unencumbered by the encroachment of its neighbors. Standards often grew tall and straight with a single trunk and spreading branches. Their density in a coppice forest varied, but standards range from 11-48 per hectare.[12] Yearly the neighboring trees are felled as fuel collectors cut them down to the ground (coppice stools). This thinning event has several benefits. Most importantly it radically increases standard insolation and carves out canopy space into which the privileged tree can grow. Additionally, from the stools grow shoots, which are cut in shorter intervals and provide continuous wood fuel. This short-rotation understory is often composed of species like holm and holly oak (evergreens), which sprout easily and copiously from stumps.[13] Coppice shoots have vigorous growth at first, until ultimately they begin to compete with the more established trees for light and nutrients, at which point their growth becomes more restricted and they are thinned once again.[14] Finally, as the thick canopy is punctured, solar radiation on the forest floor increases microbial activity and accelerates the decay of forest litter, making the soil environment markedly more nutrient-rich.[15]

Situating pre-modern agricultural practice within this ecological context can unlock some of the more opaque articulations of these data. Reconstructing land use strategies can easily be marred by modern presuppositions about the temporality of agricultural systems, labor input costs, and productivity expectations. It is, however, paramount to audit such assumptions, otherwise the traces of human subsistence techniques and adaptive solutions are relegated to unintelligible riddles. A confounding assumption, for example, is that of the yearly crop cycle. Maximizing productive output within a permanent, confined parcel of land is a costly practice that depletes the soil and requires multiple annual hoeings as well as fertilization. This strategy is neither ubiquitous nor inevitable, and its adoption is wholly divorced from the developments of certain technologies. Likewise, the parceling of arable land units to the individualist-capitalist-rational man, owner and maximalist cultivator, is a modernist paradigm that situates land as a passive object occupied and dominated by man, the center.[16] Individual ownership cannot be the assumed orientation toward land tenure in the prehistoric period. Cultivation is a naturally collaborative process that requires an abundance of labor at intervals throughout the year, and the topography and soil quality of a region can be variable, requiring diverse practices and produce unconducive to the distribution of isolated units of production.

The three axes of space, population, and time are most salient to the conceptualization of cultivation strategies. Where space is abundant and the population per square mile is low, a strategy called *shifting cultivation* is often deployed.[17] Patches of vegetation are cleared and cultivars are planted.

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[12] In the Devin Wood in the Czech Republic, standards decreased over time, with 48 per hectare counted in 1808 but only 10 per hectare in 1938 (Altman et al., 2013)

[13] Hughes, 2011.

[14] Kabukcu, 2018.

[15] Altman et al., 2013.

[16] Relaki & Catapoti, 1981.

[17] Netting, 1986.

After only 2-3 years, the ephemeral field returns to its natural state, and the farmers carve out another assemblage of harvestable plots for the following year. This process is often cyclical, wherein former plots are reused at intervals. The time depth in these cases is, however, essential to the success of the harvest, and the fallow period must be long enough for the soil quality to be restored, which can take several decades.[18] Indeed the initial labor cost of clearing an arable tract is high, ultimately the respite from consecutive hoeings and fertilizing depleted soils (which also requires the year-round care of manure-producing animals) saves the farmer up to 100 man-days[19] per yearly crop-cycle.[20]

Population density and available land are, however, limiting factors. Shifting cultivation requires constant movement, and when the population to arable land ratio tips unfavorably, this strategy becomes untenable. In these cases *intensive* cultivation will often be substituted for *extensive* cultivation, demanding more consecutive productive cycles from a given plot. Depending on the extent of available land, fallow periods are reduced, such that one can return to the same location prior to full afforestation. This is often referred to as "bush fallow," which rests a field for 6-10 years after 1-8 years of active cultivation.[21] A truncated bush fallow period yields the growth of small trees and bushes, while a "short fallow" only permits the growth of grasses. The fallow interval is dictated by the inherent or applied quality of the soil in use. Some rich soils, especially those fed by alluvial deposits from episodic flooding, strong red clays and loams, and volcanic soils, can sustain constant cultivation, while weaker soils of the sandy, acidic, or leached variety can only bear a cultivation strategy that allows for a longer forest fallow interval. A landscape is not, however, homogenous, and a mixed cultivation approach is quite common even under conditions that demand intensive cultivation: demographic growth and higher population densities. Farmers may intensify in areas that can sustain such short crop/fallow intervals at low cost, or areas in proximity to a source of fertilizer such as household waste and/or manure (infield), while summoning a shifting strategy at the periphery and/or in less fertile soils (outfield).

In Greece prior to the introduction of mechanized farming practices and chemical fertilizers, the infield/outfield strategy was widespread.[22] Typically the lower lying, more accessible fields supported intensive cultivation of crops considered more demanding, such as wheat, pulses, and summer vegetables. Beyond the proximal, fertilizable fields, sloped uplands could foster winter grain crops (oat, lentil, vetch) and an alternating uncultivated fallow (used for pasturage) or cultivated fallow (used for fodder) when necessary. Finally, the higher slopes beyond the cultivated area were where sheep and goats were grazed in the summer. Crop rotation in the outfield was likewise built into the crop-fallow cycle, featuring tiered yearly harvests based on the demands of various crops. It was common, for example, for winter wheat, grown on recently fallowed land, to be followed the next year

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[18] Ibid., p. 64.

[19] This term is a conventional measure of labor requirements, however it ought not convey that agricultural practices were solely the domain of men. On the contrary, modern pre-mechanized analogs from Greece suggest that the entire household engaged in such tasks (see Halstead, 2014).

[20] Netting 1986, p. 74; Kirch, 1994.

[21] Variation in cultivation and fallow intervals depends on the quality of the soil; Netting 1986, Boserup, 1965.

[22] The pre-mechanized Greek practices described in this paragraph are all drawn from Halstead 2014, in which Halstead has gathered and published conversations with elderly Greek farmers (those who practiced non-mechanized farming in the early 20th century).

by winter barley or oats, then pulses for fodder, such as grass pea and bitter or common vetch. Depending on the size and quality of one's landholding(s), farmers would often forgo the uncultivated fallow period altogether, preferring to plant a summer crop or late winter pulse.

Much like the contrived opposition between farmer and forest, grazing animals have long been saddled with the blame for forest destruction. Goats in particular, with their predilection for woody growth, can threaten new tree growth and affect those taxa that are higher value but slower to grow, like oak. As such, it would be intuitive to include the territory of the pastoralist in this study, since the choice in land-use for pasturage would attest to a higher valuation of one's flocks over the forest resources. Yet the threat to forest health is not in this practice of diffuse pressure, but rather in the fact that "it makes permanent what destruction goes before."[23] In other words, grazing does not degrade a healthy forest, but it prevents a degraded forest from recovering its health. Furthermore, the intersection of pasture, forest, and farm is actually an imbricated, cadenced system of plural uses.[24] Herders fodder their animals in the woods seasonally, and they feed on the leafy debris shrubs, and shoots; they may then move into agricultural fields, feeding on the stubble leftover after harvest or on fallowed fields.[25] These movements are rhythmically overlaid onto established precincts, rather than confined to bounded and exclusive pasture spaces. Moreover, these movements make the territorial scope of a herder fluid and indefinable, and, despite their being the exemplum of Hardin's thesis, decidedly *not* users of common-pool resources. In Lance Robinson's groundbreaking 2010 article "Open Property and Complex Mosaics: Variants in tenure regimes across pastoralist socio-ecological systems," he argues that the relationship between pastoralists and their grazing territories fails to adhere to one of the defining features of CPRs, which is "clear territorial and social group boundaries."[26] Given the fact that pastoralists can be in any number with open group membership and can move freely across enormous landscapes, this system of tenure is more akin to a "non-property open-access" arrangement. Rainfall, Robinson suggests, is a key driver behind this type of engagement and enforces flexibility and mobility. When one is seeking forage, they must move toward areas with high or recent rainfall, which is, especially in the Mediterranean, quite variable. Territorial boundaries, therefore, would be difficult to define and to enforce, especially when complicated by the agro-pastoral mosaics that are often anchored by individual relationships with farmers. Consequently, the management of pasture lands is excluded from this study.

1.2 **Theoretical Approach**

1.2.1 *Hardin, Ostrom, and The Commons*

Hardin's thesis relating to the inexorability of the *tragedy of the commons* was nested within a larger comment on the insoluble problem of a growing global population within a world with finite

[23] Hughes & Thirgood, 1982, p. 65.
[24] Cf. Rowton, 1973; Finklestein & Perevolotsky, 1990; Forbes, 1995; Horden & Purcell, 2000; Hall, 2015; Kardulias, 2015; Koster & Koster, 1976.
[25] Chang, 1992.
[26] Robinson, 2019.

resources. Any way you approach the question of population growth, he argues, either through the lens of energy acquisition, minimizing energy outputs, or minimizing population growth rates, there is no practical path to maximizing both population and the greater good. In support of this insoluble paradigm, Hardin marshals a handful of imagined solutions to the problem of resource scarcity (education, social enforcement of optimum withdrawals, population control), which are subsequently undermined by hypothetical anecdotes and logical proofs in parallel; education is perishable, appeals to conscience beget guilt (and schizophrenia!), and population controls are thwarted by the UN's Universal Declaration of Human Rights. Even privatization, which Hardin otherwise forwarded as panacea, is impotent under conditions not conducive to drawing boundaries, such as atmospheric and water pollution. Foundational to the threats to the greater good and issues in potential solutions is the axiom that a rational being will seek to maximize their *personal* gain if the negative consequences of doing so are *shared*.

Hardin was neither the first nor the only voice concerned with common-property (mis)management, but his pithy phrase brought the matter out of the recesses of economics literature and into the mainstream.[27] The merits of this argument, however, are balanced if not eclipsed by its problems. On the one hand, corporate greed and deferred responsibility are indeed caustic forces exerted on the environment. Overfishing, pollution, the production and disposal of waste, fast fashion, soil depletion, deforestation, and countless other collateral effects of modern profit-making are the direct parallels of Hardin's rational herder: whole profits compel choices more than shared or fractional harm. On the other hand, however, the application of the competitive exclusion principle in the biological and economic theaters is speculation presented as fact. As Frischmann, Marciano, and Ramello point out, both biologists and economists still debate the veracity of this phenomenon, especially in human populations, and note that even contemporaries of Hardin's found fault in his erroneous assumption that complete competition begets monopolies.[28] Moreover his central theme (though mostly elided in subsequent scholarship), population control, is the most disturbing. Without trepidation or euphemism, an article subheading reads "Freedom to Breed is Intolerable," and laments the UN's cementing of human procreation rights.[29] Though no mitigating measure is directly proposed, context suggests that "a privatization approach (like a transferable right for any adult to be the biological parent to one child)" could be a practical policy approach.[30] Finally, Hardin conflates the many dimensions of open-access, the public good, and common property. While the term "commons" is deployed in the article in all the aforementioned contexts, its definition is much more limited. Unlike the air or street lights, the commons are necessarily *excludable* and *subtractable*.[31] The air we breathe is open-access, and there is no practical measure one can take that would allow some but not all to breathe particular and circumscribed units of air, and therefore it is not *commonly* owned but rather exempted from ownership. Furthermore, the ability to see your environment in an urban setting at

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[27] See Carroll et al., 1979; Coase, 1960; Demsetz, 1967; Johnson & Libecap, 1982.
[28] Frischmann et al., 2019, pp. 213-214.
[29] Hardin, 1968, p. 1246.
[30] Frischmann et al., 2019, p. 216.
[31] Ostrom, 1990, pp. 32-33.

night does not make *less* light available to a neighbor; you do not subtract light units from a finite pool. As such, crowding and population growth have no effect on public goods.

Others have taken a different tack in response to imminent ruin, prescribing an expansion of private property rights and the elimination of commonly held resources. Smith (1981) and Welch (1983), in response to both Demsetz' influential "Towards a Theory of Property Rights" (1967) and Hardin's hand wringing, conclude that private ownership, which internalizes both negative and positive externalities, would resolve the archetypal pasture dilemma; the herder grazing his animals on their own privately held land would incur the sum of the negative consequences of overgrazing and consequently would elect to stock a sustainable number of animals.[32]

Hardin's call to action–introduce state regulations–has been heeded to a degree in the context of public policy. For both common and open-access resources, governments have introduced regulations in order to stem tragedy and ruin. Fisheries are heavily regulated, forests have become nationalized in some countries, and many have pledged to reduce CO2 emissions. Elinor Ostrom, however, challenges both the necessity and the efficacy of the top-down state regulation and privatization solution. In both cases, she argues, the formula is fixed and requires that a central, external authority doles out either restrictions on use or private property rights, despite the resources' diverse circumstances. Drawing boundary lines around fish resources is impossible, as is assigning private access to pasture when rainfall (and therefore fodder sources) are variable and unpredictable. One without intimate knowledge of a particular resource, moreover, cannot accurately assess fairness in administering access rights, carrying capacities, and the needs of the users.[33] Rather, she states that "instead of presuming that the individuals sharing a commons are inevitably caught in a trap from which they cannot escape, I argue that the capacity of individuals to extricate themselves from various types of dilemma situations *varies* from situation to situation."[34] The inherent heterogeneity of resource types, communities of users, and culturally accepted rules of use demands heterogeneous, bottom-up approaches to sustainable common-property arrangements, as opposed to uniform edicts delivered by external authorities.

Fundamental to Ostrom's perspective is the observation that in experimental contexts, where "tragic" outcomes have been replicated through the prisoner's dilemma game, the outcomes that result in *defection*–a herder seeks profit over cooperation and overstocks his animals to the detriment of the resource–are avoided with a) iterative games through which players learn the behaviors of others and develop trust and b) the introduction of cooperative communication between game cycles.[35] Endemic to this adjustment in the traditional game is the fact that players have *more* complete knowledge of the behaviors of their collaborators, the realities of the resource itself (a particular field in a particular climate over a number of years) and its carrying capacity than an external authority. The contracts and arrangements that are agreed upon thus bring the herders closer to equilibrium (maximizing their yield without costs to the health and longevity of the field) than any other strategy, and the cost of enforcing the contract can likewise be shared.

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[32] Demsetz, 1967; Johnson, 1972; Smith, 1981; Welch, 1983.

[33] Ostrom, 1990, pp. 13-14.

[34] Ostrom, 1990, p. 14.

[35] North, 1990, pp. 12-15; Ostrom, 1990, pp. 15-18; Ostrom, 2007, p. 15183.

Outside of an experimental context, however, these contractual arrangements are more problematic. In real world scenarios, individuals are not archetypal rational actors who have complete information and make similar (opportunistic) choices in similar circumstances according to stable criteria. This behavioral assumption is demonstrably erroneous, and accounting for the diversity of inputs that influence choice is the cornerstone of *New Institutional Economics* (NIE from hereon), an economic discipline to which Ostrom belongs. According to this school of thought, the notion of the rational economic actor is a convenient fiction that lubricates neoclassical economic modeling. In reality, however, North states plainly:

> Many cases are ones not simply of wealth maximizing behavior, but of altruism and self-imposed constraints, which radically change the outcomes with respect to the choices that people actually make. Similarly, we find that people decipher the environment by processing information through preexisting mental constructs through which they understand the environment and solve problems they confront. Both the computational abilities of the players and the complexity of the problems to be solved must be taken into account in understanding the issues.[36]

Interactions between these fallible and diverse actors, whose information about a given issue/transaction is biased and incomplete, are consequently unpredictable. Some individuals in some circumstances with limited information may behave opportunistically, while others may be inclined towards altruism. According to New Institutionalists, it is precisely this unpredictability in the behaviors and motivations of others that begets institutions.[37] Both formally (laws, rules, contracts) and informally (social mores, taboos, conventions), institutions structure behavior and limit the field of choices an individual is willing to make, to varying degrees.[38] Agents are more able to safely interact and more willing to participate in transactions, since institutional rules of play have reduced uncertainty. In light of this Ostrom developed a "second-generation model of rationality," which asserts that human actors are "complex, fallible learners who seek to do as well as they can given the constraints that they face and who are able to learn heuristics, norms, rules, and how to craft rules to improve achieved outcomes."[39]

Returning to the Prisoner's dilemma, the agreement on the carrying capacity of the pasture (accurate or not), the trust that herders will stock the number of animals they asserted they would under the agreement made, and the confidence that defectors/opportunists will be a) detected and b) penalized provide the requisite behavioral boundaries that allow for safer cooperation. In the laboratory context the herders and the animals are hypothetical, and as such the rules of the game are easily enforced. A player stocks a particular number of animals or violates the contract because they say that they do, not because a separate observation about their behavior has been reported. In other words, the rules of play as they are imagined effect stable and predictable outcomes. In the real world, however, the negotiations about the carrying capacity of the land, the gathering of information about a

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[36] North, 1990, p. 20.

[37] North, 1990, p. 25; New Institutional Economics has a rich and prolific literature. Some overviews can be found here: Alston et al. 2018; Coase, 1984; Eggertsson, 1990; Furubotn & Richter, 1997; Menard & Shirley, 2005; Olson, 1965; Williamson, 1985; Williamson, 2000.

[38] North, 1990, p. 4 and 25.

[39] Ostrom, 1998, p. 9; Frischmann et al., 2019, p. 219.

herder's behavior, and the enforcement of the contract are, to varying degrees, quite costly ventures. Perhaps soil and climate studies need to be conducted, or a third-party investigative or policing agent needs to be hired in order to report infractions and administer penalties; perhaps a particular space and a particular amount of time need to be dedicated each year to discuss shared maintenance obligations and arbitrate disputes. These are a sample of the *transaction costs* of a communal property arrangement, and the more uncertain and more complex the transaction, the higher the cost to one or all parties.[40]

Institutions, therefore, have the effect of lubricating exchange and collaboration but are not necessarily the best or most efficient instruments, and the structure of institutions reflects the scale and complexity of the market. Where a few agents repeatedly engage in exchange and belong to the same or similar social groupings *in as much as their social norms and values align*, informal social constraints suffice to mitigate uncertainty.[41] For example, a visitor from a neighboring village in Messenia may feel confident that they will be treated hospitably, offered boarding and food, and under no threat of personal injury because the social constraints of the institution of *xenia* demand particular behaviors related to mutual hospitality; the hosts, moreover, have confidence that their guest will not abuse their kindness by stealing or otherwise harming the property and its occupants. This is not to say that these informal rules are never broken, but simply that their existence makes the behaviors of strangers *more* predictable and the cost of assessing the trustworthiness of each party (host and guest) and the enforcement of lawful behavior much lower. In larger exchange markets, where less is known about the social conventions of other agents and there are fewer repeated interactions between parties, trust is secured through the formalization of certain, more specific sets of rules; these may indeed reflect informal rules (mores, taboos, conventions) already in existence, or they may override or reverse them. Formal constraints are scaled not only in their specificity but also in their conservatism, ranging from "constitutions, to statute and common laws, to specific bylaws, and finally to individual contracts... from general rules to particular specifications."[42] At this scale more investment in policing and enforcement is necessary, since threat to personal reputation has little impact in larger markets where the promise of repeated exchanges has less currency. If our visitor were a merchant, arriving in town from very far away, the *formal* constraints of, perhaps, a merchant's code of conduct and local property laws might yield the same results as *xenia* among familiar parties. Rather than replacing informal rules, these constraints run parallel with them but curb the appeal of one-sided profits in these circumstances transaction repetition and/or personal reputation matter less. In other words, were the merchant tempted to sell amphorae filled with vinegar but labeled "wine," rob the locals of their valuables, then kick a dog, they could abscond into the night without recourse. The rules of social decorum, penalties for stealing property, and vocational codes of conduct make this outcome *less desirable*, despite the fact that the merchant would profit from it.

With this in mind, the herder who *always* chooses maximum gains and partial (shared) consequences appears less axiomatic and more incidental. Just like the prisoner's dilemma, Hardin's herder does not coordinate with others, make enforced concessions, or organize such that collective net gain is assured. It is practice without any formal or informal behavioral constraints, which is far from

[40] Coase, 1937; Coase, 1960; North, 1990; Ostrom, 1990; Williamson, 1979; Williamson & Masten, 1999.
[41] North, 1990, pp. 36-45.
[42] North, 1990, p. 47.

universal. Ostrom acknowledges that while indeed the costs of organizing a cooperative strategy are high and the benefits are partial (shared), "the returns they receive from their appropriation efforts will be lower when decisions are made independently than they would have been otherwise."[43] This is a key incentive absent from the original paradigm, though it is contingent on each individual's perception of the relative costs and benefits as well as the level to which they regard themselves as interconnected with other CPR users.[44] Some biases that discourage cooperation are easier to overcome than others.[45] An understanding of the resource that includes environmental variables and, ultimately, sustainable levels of extraction are learned through time and from generation to generation (though sometimes, as is the case with groundwater, this knowledge requires intentional and expensive formal studies), whereas the propensity to discount future returns can be inconsistent and/or persistent. Such discounting encourages resource users, either as a product of their personal proclivities or circumstances of extreme uncertainty, to privilege the reality of their immediate needs over the prospect of their future ones. Despite these obstacles, collective management ventures have been undertaken routinely, both now and in the past, and the costs of establishing rules of use, garnering commitments to compliance, mobilizing monitoring systems, formalizing penalty schemes, and introducing operational flexibility to offset error and maintain adaptive resilience have been readily taken on in the interest of preserving and sharing equitably the benefits of a common-pool resource.

It is certainly difficult to generalize about the ubiquity of successful CPR management strategies, and there remains a black box around the origins of these institutions (elsewhere termed the "problem of supply").[46] Based on her observations about California's groundwater basin disputes, a rare glimpse into the *formation* of an institution, Ostrom posits that development is gradual and incremental. Creating a space in which CPR users can discuss particular issues relating to the resource, for example, is a low cost investment that clears a path for later, more formal policy decisions.[47] Over time, attempts at fair, beneficial, and sustainable use-practices may be codified or adjusted in accordance with the observed outcomes, which in turn maximizes compliance. The key to the ultimate success (longevity, robustness) of CPR-related institutions, Ostrom observes, lies not in the operational rules that manifest but in the structuring of the rule-making institutional apparatus. In other words, the insurmountable obstacle that Hardin identified–that there is "no technical solution to the problem" of pathological over-extraction–is illusory.[48] Rather, there is no *one* solution; resilient institutions that forestall tragedy exist and have existed for centuries, and their rules are diverse and specific to the ecological, cultural, political, and economic contexts of their communities. What links them is what

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[43] Ostrom, 1990, pp. 38-39.

[44] Ostrom, 1990, pp. 33-34.

[45] In addition to variables related to knowledge and perception, Ostrom identifies four *internal* variables that determine choice of action: a) internal norms, which define an individual's valuation and expectations of their own behaviors divorced from external consequences, b) discount rates, which, dependent on circumstance, informs one's proclivity to reap a benefit in the short term that costs them in the long term, c) expected benefits of the choice, and d) expected costs of the choice (Ostrom, 1990, pp. 33-38).

[46] Bates goes as far as to say that *initiating* coordination and management institutions is itself a collective dilemma, compounding the dilemma pertaining to resource use (Bates, 1988).

[47] Ostrom, 1990, p. 141.

[48] Hardin, 1968, p. 1243.

Ostrom has termed "design principles," which relate to institutional *structure*, namely clearly defined boundaries both of the resource itself and the users who hold rights to it, alignment between the attributes of the resource with its use-prescriptions, collective choice arrangements, wherein those relying on the CPR for economic gain have an opportunity to contribute to decision-making concerning that resource, internal monitoring, graduated sanctions, mechanisms for conflict resolution, and the recognized right to self-organize by the state. These principles thus require a bottom-up approach, establishing a local system of regulation and arbitration without state intervention.[49]

In the three decades following her paradigm-shifting publication, Ostrom's influence has penetrated arenas beyond economic and even scholarly discourse, as her design principles and polycentric approach have become the gold standard for policy evaluations and predicting the efficacy and robustness of collective self-governing institutions.[50] Beyond just natural resources, contemporary commons scholarship has applied this perspective to a more diverse set of resources, such as knowledge and infrastructure.[51] Indeed, critiques of the design principles and the book's overall approach have also emerged. Some cite the misattribution of institutional properties to success or failure as opposed to historical, political, or cultural contexts (functional critique), while others find fault with its disregard of power and structural inequality (apolitical critique). There have also been methodological reassessments that take fault with the positivist slant of the design principles (methodological critique) as well as a contingent of philosophers who question whether a sustainable outcome is objectively good and whether the communities engaged in collective management are not passive actors under state coercion (normative critique).[52] Regardless of the position one takes on Ostrom's theory, *Governing the Commons* is still the centerpiece of contemporary commons discourse. Ultimately, the integration of these criticisms into an updated paradigm was Ostrom's objective all along.[53]

1.2.2 *New Approaches*

The chronological limits of this project mean that specific institutional attributes and mechanisms for rule-making are impossible to observe. At this temporal depth, the only testimony available is the ecological outcomes and, to a degree, the *lack* of evidence for state regulation of CPRs in the Linear B documents. As such, rather than tracking the sustainability/robustness of the *institutions*, as Ostrom does with her design principles, I track the sustainability of the resource itself and infer shared values in turn. As it is laid out, the sustainable use of a common-pool resource is predicated on the existence of collective-choice institutions, which inherently control extraction such

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[49] Ostrom, 1990, pp. 88-102.

[50] Including but not limited to: Agrawal et al., 2014; Cox et al., 2010; Herzberg, 2020; Parisi et al., 2005.

[51] Including but not limited to: Frischmann et al., 2014; Reichman et al., 2016; Safner, 2016; Skarbek, 2014; Strandburg et al., 2017; Schweik et al., 2012; Vickrey, 1969.

[52] The recognition and categorization of these four types of critiques comes from Quintana & Campbell, 2019. See this article for a full bibliography for each type.

[53] "This list of design principles is still quite speculative. I am not yet willing to argue that these design principles are necessary conditions for achieving institutional robustness in CPR settings. Further theoretical and empirical work is needed before a strong assertion of necessity can be made" (Ostrom, 1990, p. 90).

that the *net benefits* to the community of users are maximized over a long period of time. In order for the users to mitigate their own over-use, they must trust other users are doing the same. Otherwise, they might profit *less* in the short term but incur the same negative consequences that the behavior of the other users may bear. Trust is born of assured compliance–through monitoring and penalties–which in turn is born of institutions, informal or formal.

While we cannot access the operational-rules or even governing mechanisms of Bronze Age CPR institutions (L2 and L3 in Figure 1.3), at this moment in early state formation we may actually be privy to institutional *formalization*, where social norms evolve into dynamic sets of rules. Based on a given ecological outcome, we can infer certain embedded orientations towards a resource *and* certain political conditions that begot formal institutions and institutional cooperation. In this way we can align the environmental outcomes with schematic pathways of thoughts and decisions and chart those otherwise intangible provinces of choice in the landscape, deducing the various orientations toward resources that asserted themselves and establishing whether those embedded beliefs/values were conducive to cooperative sustainability (L1 in Figure 1.3).

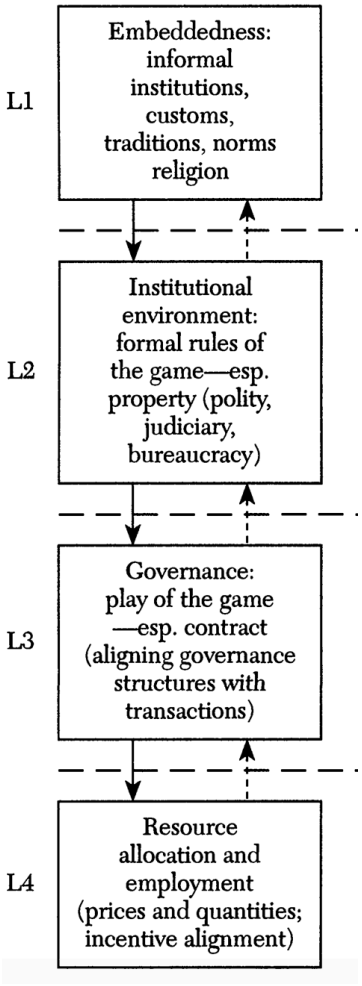


Figure 1.3 Four levels of social analysis (selection from Williamson, 2000, fig. 1).

Level 1, embeddedness, has long been treated within economic theory as a ubiquitous but generally unspecifiable phenomenon, due to its immense variety and relative invisibility. Religious, cultural, or cognitive norms vary from society to society, community to community, and even person to person, yet the influence on economic behavior cannot be understated.[54] According to Zukin and DiMaggio (1990),

> Culture sets limits to economic rationality: it proscribes or limits market exchange in sacred objects... or between ritually classified groups.... Culture, in the form of beliefs and ideologies, taken for granted assumptions, or formal rule systems, also prescribes strategies of self-interested action ... and defines the actors who may legitimately engage in them.... Culture provides scripts for applying different strategies for different classes of exchange. Finally, norms and constitutive understanding regulate market exchange.[55]

In other words, what constitutes the "embeddedness" box in Figure 1.3 molds the myriad permutations of formal institutions, organizations, and transactions in the lower three levels, and yet we lack the theoretical specification to unlock its many dimensions.[56] This is especially true when considering the informal institutions of prehistory. At the very least, if we lack specific knowledge

[54] Dequech, 2003; Zukin & DiMaggio, 1990.
[55] Zukin & DiMaggio, 1990, p. 17.
[56] "The concept of embeddedness remains in need of more theoretical specification" (Smelser & Swedberg, 1994).

about the embedded norms in a modern or historical context, we can consult living people, texts, legislation, myth, poetry, and other direct or indirect testimonies that bring systems of values into higher resolution. We then might imagine how they change over time and articulate the features of the economic landscape. In prehistory, however, those foundational attributes seem too remote and too ephemeral to grasp.

Therefore, with respect to the formalization of institutions governing natural resources (including but not limited to common-property arrangements), I have developed a *heuristic* tool that schematizes the attitudes and values constituting L1 institutions (cognitive elements or social cognition[57]) of the resource users as they a) intersect with and/or contribute to power structures and b) precipitate particular ecological outcomes. Rather than a predictive or prescriptive paradigm, this frames relationships and broadly charts outcome tendencies. To illustrate the outcomes and combinations of these variables, I have supplied a flow chart (Figure 1.4).

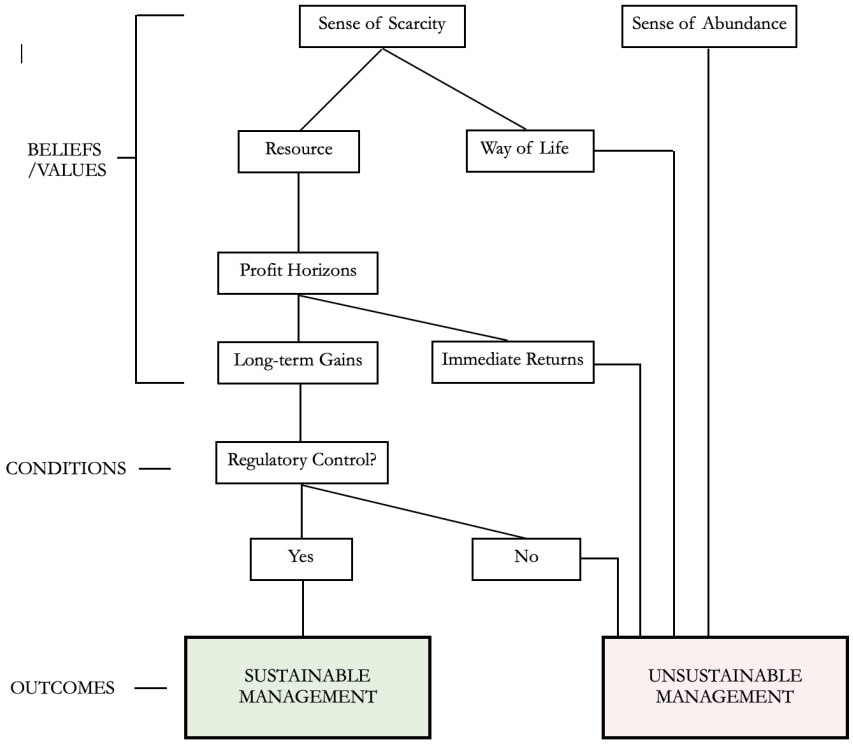


Figure 1.4 Schematic flow chart illustrating the relationship between sustainability outcomes and other salient variables.

Given a sustainable outcome, therefore, we can surmise both the cognitive norms of the community of users, their authority to make management decisions, and, in the case of common property arrangements, the likelihood of the community of users having organized a formal system of behavioral rules governing resource management and extraction. Given an *un*sustainable outcome, on the other hand, we can infer one–or a combination–of four possible contributing factors relating to embedded beliefs about scarcity/abundance, discount rates, regulatory control, or conditions of cognitive consensus *without* formal organization (formal institutions).

First, the governing principle that inflects all procurement decisions is an overriding sense of scarcity or abundance. In circumstances where the transport of wood is relatively easy (access to cheap labor, river courses, motorized hauling vehicles, etc.) and the forest seems to be infinite, appropriators

[57] DiMaggio, 1990; DiMaggio, 1994; DiMaggio, 1997.

can maximize profits by clearcutting and moving quickly across a landscape seemingly in perpetuity. Early English colonists in North America, for example, were drawn to the continent in part as a result of a wood scarcity crisis occurring in the British Isles in the early 17th c. CE.[58] The overwhelming abundance of dense forests on the eastern seaboard brought hopes for tree and fuel burdened industries, such as iron and silk production, as well as glass-making and copper-working. Their practices, therefore, aligned with this belief, and colonial engagements with North American forests set a course for centuries of (over)exploitation. Boundless forests meant boundless profits if one could move freely across the landscape. An overriding sense of scarcity, on the other hand, can have dual outcomes. Perhaps most intuitively, scarcity-based beliefs can engender conservation efforts when the resource itself is perceived as limited and shrinking. This is evident in modern conservation practices, mentioned above, as well as in 17th c. Europe. The wood scarcity crisis in England, for example, prompted many conservation-oriented laws to be passed. In 1613, upon their failure to curb overuse, Arthur Standish, an agricultural writer, championed timber plantations, the outsourcing of iron and glass manufacturing, and the planting and pollarding of hedges/trees on common or private plots for individual use.[59] When certain ways of life, on the other hand, are perceived as scarce, the outcomes and responses differ. A mill employee in Oregon whose wages and livelihood depend on the continued operations of the logging industry may view conservation efforts as threatening to their way of life. Likewise, when European colonizers moved to North America, like many urban dwellers they sought a second Eden and expected a fecund, wooded paradise. Upon their arrival, however, many found that the more urgent scarcity of food, comforts, and safety within the western wilderness trumped the sense of scarcity that compelled them initially. Their focus consequently shifted to conquering, carving, and vanquishing the threats of the wooded wild.[60]

The second salient dimension of appropriator values is the profit horizon. Sustainable use, by definition, ought to be attractive to every resource appropriator. Resource degradation within one's lifetime is of course costly, and the threat of degradation in future generations–their children's or grandchildren's lifetime–would naturally temper overzealous consumption and short-term profit-maximization attitudes. Yet everywhere we look, especially in places subject to hegemonic capitalist values, short-term returns on unsustainable practices prevail. Discounting future returns feels counterintuitive, nevertheless the agriculture industrial complex in the U.S. and global deforestation trends testify to the attractiveness of this exploitation model, even when the resource in question is privately owned and its longevity directly benefits the user and her family. In fact, it is the very force that ensures the "tragedy of the commons" according to Hardin's model. The question is thus *what* indeed induces appropriators to seek short-term returns that undermine the longevity of their profitability.

One answer may be that these measures are a crisis response; under conditions of, perhaps, warfare, drought, pestilence, oppressive taxation/costs, appropriators who "are uncertain whether or not there will be sufficient food to survive the year will discount future returns heavily when traded off

[58] *Cf*. Pluymers, 2021; Nash, 2001.
[59] Pluymers, 2021; Standish, 1613.
[60] Nash, 2001, pp. 38-43.

against increasing the probability of survival during the current year."[61] In other words, resource users only value future returns when their current survival is assured.

Another coercive force is the market. In the U.S. the staggeringly vast farmlands in the Midwest were once ribboned with "windbreaks, shelterbelts, and filter strips" that were planted after the Dust Bowl crisis in order to rebuild and maintain the diminishing topsoil, however, in the 1970s the Secretary of Agriculture, Earl Butz, encouraged and incentivized farmers to rip out these safeguards and plant "fencerow to fencerow," catering to the increasingly rich and industrialized agribusiness.[62] At the same time, the U.S. quintupled its grain exports to other countries and encouraged farmers to aggressively monocrop export-bound crops: wheat, corn, and soy.[63] As a result, crop prices and soil quality dropped catastrophically, leading the federal government to inflate the subsidies that supplement the farmer's negative returns, upon which they now wholly rely.[64] At every step, the farmer is working against their own *long term* interests. In the 1970s and 1980s the Dust Bowl crisis was a recent, if inherited, memory, and yet under the encouragement of a politician and in the interest of agricultural corporations that export or process their produce (*cf.* animal feed, corn syrup, feed additives, and other non-food byproducts), they were coerced into compromising their essential resource: the fertile topsoil. Consequently, agribusiness makes billions, while the farmer earns between 4 and 21 cents on every consumer dollar, if they were able to keep their farms at all.[65]

Finally, deferred responsibility is an emotional orientation that colors use-practices, especially when the externalities affect a *community* of users but the cost of prevention/correction afflicts an *individual* user. The San Joaquin Valley in California, for example, hosts 300,000 hectares of irrigated farmland that sit atop a water-tight layer of clay. This clay layer makes drainage from the fields impossible, causing waterlogging, salt accumulation, and pooled toxic compounds. Naturally these phenomena trigger myriad bad outcomes in several ecosystems and threaten the productive viability of the valley *in toto*. Experts agree that the solution to the problem would be the construction of a master drain that carries the salty and toxic water out of the valley, however political gridlock fueled by "strong opposition from the environmental community and urban taxpayers against toxics management and subsidized irrigated agriculture" have stalled progress for over 40 years.[66] While the problem is as urgent as ever, responsibility has been forced onto the shoulders of farmers, who are urged to invest in on-farm management practices that have only moderate, short-term outcomes (the water is drained from the field but stays in the valley), which merely kick the can down the road. Based on interviews from 1987, the farmers were reluctant to take on individual, costly mitigation measures that may ultimately benefit them but were perceived as being beyond their individual responsibility.[67] This is, of course, a reasonable position.

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[61] Ostrom, 1990, p. 35.
[62] Manning, 2004.
[63] Between 1972 and 1981 exported grain went from an $8 billion business to a $44 billion business (Manning, 2004, p. 20).
[64] Manning, 2004, p.21.
[65] Manning, 2004, p. 22; 4-21 cents is an average taken in 1994; now, almost 30 years later, the average may be even less.
[66] Hukkinen, 1998.
[67] Hukkinen, 1998, pp. 114-115.

The combination of values/beliefs about scarcity and returns horizons that have a sustainability trajectory, the *sustainability pathway* on the left side of the flow chart in Figure 1.4, is vexed if the users who hold these beliefs are not in a position of regulatory power. Simply put, without a degree of control over use-practices, the beliefs and values of the appropriators are irrelevant to sustainability outcomes. A group of appropriators may hold the belief that the resource fundamental to their survival is scarce and have an interest in investing in future returns (for their children, grandchildren, etc.), however if exogenous policy makers ultimately have authority over the ways the appropriators engage with the resource, an institutional framework perhaps guided by a) a sense of abundance or b) profit incentives, then the pathway shifts to the following:

a) abundance → unsustainable management
b) immediate returns ↗

Ostrom underlines the importance of users having influence over operational rules (and the ability to make changes to them when appropriate) in her list of design principles that illustrate the qualities of long-enduring CPR management institutions. While her focus is on a later and more specific manifestation of sustainable use practices, it is evident that for a sustainable use strategy to materialize (relevant here) *and* to be resilient over time, "most individuals affected by the operational rules [must] participate in modifying the operational rules," and "the rights of appropriators to devise their own institutions [must not be] challenged by external governmental authorities."[68] Failure to hold recognized power over use-practices results in external institutions with differing orientations to prescribe rules reflective of *their* values, which often follows the unsustainability pathway.

Such was the case in Mawelle, a fishing village in Sri Lanka. Here, coastal fishermen regulated the number of nets deployed, duration and placement of their use, and the sequence in which they were deployed. This maintained fish stocks and enforced fair access to desired fishing locations. In the 1930s legislation was introduced that required the nets to be formally registered with the government, ceding some regulatory control to an external institution. Early on, the number of nets (n=32) was meant to be maintained at the quantity registered in 1933, however when the market for fresh fish and the local population grew in the 1940s, these limits were not enforced by the government, despite their newfound and exclusive power over such enforcement. New nets and non-local owners (wealthy business people) of net shares were introduced into the delicate system via the coercion of regulatory agents.[69] Namely, entrepreneurs who desired to launch new nets bribed state officials or promised support to elected faction leaders, inducing politicians and regulators to bend the rules for the sake of immediate, mutual gain. By 1965 the number of nets had ballooned from 32 to 108, depleting the fish stock to such a degree that local owners of net shares could no longer subsist off of their catch. Net

[68] Ostrom, 1990, p. 90.
[69] Nets were expensive to make and required eight men to operate them. Shares of the net profit and costs were distributed across eight people (eight ownership shares); these shares were heritable and supplied subsistence level portions of the catch. (Ostrom, 1990, p. 152).

owners ultimately sold their shares, held by generations of their kin before them, to the non-local entrepreneurs and worked for them as wage laborers on the fishing boats instead.[70]

This heuristic framework in certain ways aligns with Ostrom's individual choice model, which puts forth four *internal* variables that influence choice, particular to each person: internal norms, discount rates, expected costs, and expected benefits.[71] This new approach, however, brings specificity to these attitudes and allows for integration between internal and cultural/cognitive norms that inflect choice more broadly. Furthermore, this framework provides a point of access to embeddedness amenable to prehistoric contexts and this project's design.

1.3 **Methodology**

There is no evidence that directly testifies to the formulation and execution of forest and land management strategies in Bronze Age Messenia. However, three bodies of evidence speak to actions often *associated* with deliberate conservation efforts as well as incidental indicators of the relative health of the forest/agricultural land in the Bronze Age: the palynological and climate data, the geomorphology of the region in question, ethnographic and survey data, and the Linear B documents related to land tenure and taxation. The archaeological contexts of these data sets will likewise be summoned in order to sharpen and supplement the human-paleoecology of prehistoric Messenia.

1.3.1 *Environmental Reconstruction*

Locating direct evidence of human interventions in the natural environment requires the reconstruction of the ecology of the study area. Pairing observations of long term changes in plant populations with palaeoclimatic conditions provides a silhouette of human actions. Dramatic changes in the composition of local vegetation, and especially in the populations of *certain* taxa, without any indication of parallel changes in precipitation and/or temperature may index changes in plant use by human agents. Conversely, consistency in plant populations despite climatic fluctuations or human population growth could reveal conscious conservation efforts. Tracking variation in these larger systems thus provides the foundation for the more specific, granular analyses of this project.

1.3.2 *Pollen and Speleothems*

Two bodies of evidence speak to the aforementioned ecological conditions, the most important of which are pollen core samples. In certain environments the pollen spores released by plants into the air are trapped. Wetlands and lakes, unmarred by the violence of flowing water, and caves, which are shielded from destructive weather, are blanketed with layers of pollen spores that sink to the ground. Permanently wet and permanently dry conditions shield the spores from the destructive processes of oxidation and allow these layers to become deep, stratified records of local vegetation history. In the study of these ancient pollen deposits, a 1cm x 1cm sample is taken from each stratum through the

[70] Ostrom, 1990, pp. 149-157.
[71] Ostrom, 1990, pp. 36-38.

process of coring. The pollen present in these samples is identified, counted, and C14 dated. This provides a picture of the diachronic variation of the local palaeoecology, as the relative proportions of present plant taxa at various depths capture, to a degree, the proportions of those living populations.[72]

The results of this population proxy must, however, be calibrated to capture the differential volume of pollen spores released by various plant taxa. Certain plant species tend to be overrepresented in pollen core samples because their spores are more abundant or more durable, while others are underrepresented in samples because their pollen spores are carried shorter distances and may only be detectable within a small radius around their source. Pine trees, for example, are prolific pollen producers, and the spores travel great distances. This means that they tend to constitute a disproportionately large fraction of the sample assemblage, and their presence may not reflect the actual composition of local populations. Grape vines and cereal grains, on the other hand, drop without being carried very far at all.[73]

To ameliorate this incongruity between pollen assemblages and living populations, Zangger et al. (1997) sampled the pollen deposits from modern local contexts and compared the proportion of living plant species to the abundance of pollen deposited in the sample. Using the "method of transfer approach," a regressions function was applied using the quantity of pollen collected and the estimated (ranked) volume of pollen produced in order to estimate the biomass of each species.[74] Modeling this relationship in a modern context supplies the scaffolding for calibrating fossil pollen assemblages to reflect living plant populations in the past.

What is salient in this variety of data, more than the biomass of a single plant species across time, is the shifting *communities* of taxa. Evidence of depleted tree populations paired with the growth of communities of grasses may speak to deforestation and replacement with agricultural ventures. The composition of forests also marks use strategies; there is a tendency in unmanaged forests to move from larger populations of higher value, slow-growing deciduous trees, such as white oak, alder, ash, and elm, to less valuable trees that reproduce more quickly, such as pine. If the region is being cross-utilized for grazing, thick evergreen shrubs and bushes (maquis) overcome the tree populations, because grazing animals consume young tree shoots and preclude the replacement of dead and/or felled trees. In regions where grazing space does not impinge upon forested areas, the presence of goats is also visible in the palynological data, as, after comparing two small islands off Crete, one heavily grazed by the Cretan wild goats and the other ungrazed, Papageorgiou (1979) demonstrated that community diversity was much higher in the former than in the latter. Finally, certain species are amenable to suboptimal soil conditions, whose presence, in combination with the geomorphology and climate data, can testify to extreme erosion or changing precipitation patterns.[75] These conditions are called *phrygana* environments.

In the Bay of Navarino, 9 km southwest of the Palace of Nestor near modern Pylos, there existed for 6,000 years a crescent-shaped lagoon that cupped the northern end of the bay and stilled the trapped water from the hill-borne streams in a placid refuge. A sandbar and the Palaeonavarino Ridge

[72] Bottema, 1999; Pearsall, 2015.
[73] Zangger et al., 1997, p.580.
[74] Ibid., pp. 580-583
[75] Ibid., p. 578.

(which now constitutes the island of Sphacteria) insulate this feature from the Ionian sea, and for millennia its quiet surface captured the delicate pollen spores that drifted down. The alluvium filling the 1km wide lagoon, if shielded from exposure to the air in drier conditions, traps organic matter in a state of partial decomposition and preserves the pollen. The Osmanaga lagoon, as it's called, was cored three times in three decades, beginning with the University of Minnesota Messenia Expedition (UMME) in 1972, in areas that are confirmed to have been permanently wet based on the gray color of the sediment.[76] In 1972 two cores yielded ideal preservation conditions and a bounty of stratified pollen remains. Many of the strata, however, yielded poorly preserved pollen, likely due to their having been broken as they washed in from a tributary stream, making them difficult to identify.[77] In combination with their sparse sampling strategy, with a mere 10-15 taken from each of the two cores, low quality samples impacted the overall resolution of the data quite drastically. Nearly three decades later Zangger et al. (1997) justified their coring efforts by citing exactly these resolution issues, as well as Wright's decision to only quantify six categories of vegetation–pine, erica type, oak, olive, pistachio, and grasses–and the fact that maquis-type evergreen oak pollen was not differentiated from that of the large, timber-bearing deciduous oak. This distinction is critical for discerning discrete plant communities.

In the second volume of the Pylos Regional Archaeological Project (PRAP), directed by Jack L. Davis from the University of Cincinnati, Eberhard Zangger coordinated the survey and investigations into the natural environment of western Messenia.[78] This investigation included geomorphological, palynological, and geophysical analyses. Focus was returned to Osmanaga lagoon, and thanks to Wright's abovementioned pilot project, he and his colleagues were able to concentrate on areas of the lagoon (on its western side) with optimal preservation. A total of fourteen 3.72 – 4.68m deep cores were taken from the deepest portion of the Osmanaga in overlapping pairs, two of which were used for study and the other twelve were stored. Samples of 1 cm^2 were taken every 5–20 cm, depending on the thickness of the layers, and allocated to pollen analysis, while others were allocated to radiocarbon dating, sedimentological analysis, and paleontological analysis. The aggregate result is a 7,400 year vegetal history record with 34 sampled strata and 12 calibrated radiocarbon dates that anchor them. Rather than six quantified plant categories, Zangger et al. examined twenty-seven individual taxa or groups (e.g. grasses).

Critical to understanding the vegetation history of an area is the paleoclimate data. As plant communities shift and slip under the header of familiar environmental categories – phrygana, steppe, maquis, deciduous and coniferous forests – suddenly their climatic and geographic contexts demand address. Thorny burnet may proliferate on a steep slope accessible only to goats, but with the simultaneous spread of a phrygana plant community of rock rose, spiny spurge, jerusalem sage, and kermes oak, the thorny burnet attests not only to the humble contours of its geography, but to larger climatic patterns. This particular community dots arid landscapes with thin, parched soils and steep crags, and while indeed it could be argued that the expansion of such a landscape is the result of

[76] The iron minerals in the alluvium turn from brown to gray in chemical contexts impacted by the partial decomposition of organic matter (Wright, 1972).
[77] Wright, 1972.
[78] Zangger et al., 1997.

catastrophic human interventions, such as overgrazing and deforestation, the fluctuations in temperature and precipitation may eclipse, supercede, or amplify the impact of over-exploitation. The relevance of the palynological data to this project is therefore predicated on a non-correlative relationship between variations in the vegetation history and climatic fluctuations through time.

The analysis of speleothem transects, sections taken from the pointed mineral formations that grow in caves, serves as a useful proxy for ancient climatic conditions and the second body of evidence that speaks to the ancient ecology. Like tree rings, the mineral formations reveal periods of more or less growth depending on the thickness of the visible rings. In the most general sense, growth occurs when there are wetter conditions and more water filtering through the bedrock. Through the analysis of stable oxygen isotopes, however, it is possible to determine whether the wetter conditions were the result of more copious rainfall. Rainfall in particular is germane to this query, since we are primarily concerned with the quality of the growing conditions of the local flora.[79]

The levels of the oxygen isotope $\delta^{18}O$ are determined by various climatic factors, such as transport distance, condensation temperature, and moisture source; however, there is a clear inverse correlation between precipitation and $\delta^{18}O$ levels in the speleothem growth ring. With wetter conditions, there is less $\delta^{18}O$ present in the sample.[80] When growth rings of a speleothem are sampled and the stable oxygen isotope is systematically tested, precipitation patterns across time can be gleaned.

In 2015 a stalagmite transect from Mavri Trypa, a cave located on the island of Schiza off the southwest coast of the Peloponnese, was examined.[81] The morphology and growth pattern of each ring was evaluated and the levels of $\delta^{18}O$ and $\delta^{13}C$ were sampled.[82] The results of this analysis presents a fairly high resolution image of major climatic episodes, with each sample representing a mean of 6 years, from 4600 years BP to 3000 years BP.[83] In mainland chronological terms, this speleothem reflects the moisture levels of the Peloponnese from the Early Helladic II (EH II) until the Early Iron Age (EIA) ca. 1000 BCE, when the mineral formation ceased growing altogether. While the sequence observed in the stalagmite growth more directly records the rainfall and climate patterns occurring in the southwestern Peloponnese, they speak also to larger weather systems and climatic conditions resulting from atmospheric circulation and prevailing moisture transport across the Peloponnese.[84]

Weiberg and Finne (2018) and Finne et al. (2017) successfully mapped these episodes of more or less moisture with an emphasis on the early and high Mycenaean periods, roughly from Middle Helladic III (MH III) in 1750 BCE until the EIA in 1000 BCE, in an effort to gauge the relationship between occasions of environmental stress, either climate volatility or persistent extremes, and the Mycenaean state. This scope is also appropriate for this project, however the object is not to measure the socio-political impact and subsequent responses from the state, but rather to map climate data onto the palynological data such that the choices and interventions of the human agents can be

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[79] See Finne, et al., 2017, p. 6 for a full discussion of the factors that determine $\delta^{18}O$ in meteoric precipitation.

[80] More specifically, the wetter the conditions are the *less negative* the $\delta^{18}O$ levels.

[81] Finne et al., 2017; Weiberg & Finne, 2018.

[82] This stable isotope is often used as a proxy for modeling the biomass of the vegetation above the cave based on the decay of organic matter, however this line of analysis is not pertinent to the project.

[83] Samples range from 1 to 25 years (Weiberg & Finne, 2018).

[84] Weiberg & Finne, 2018.

spotlighted in moments when major changes in the vegetation *cannot* be explained by climate change. Tracking the oxygen isotope levels evinces alternating dry and wet periods throughout the late Middle Helladic to Late Helladic IIIB periods.

1.3.3 *Geomorphology and Micromorphology*

Patterns of soil deposition and erosion likewise contribute to our understanding of the natural landscape of a given area. Geomorphological studies on soils track the relative deposition volumes across time that illustrate major changes in the topography of an area. In many places in Greece the earth and vegetation are in a state of tenuous equilibrium, and the thinning of stabilizing forces, such as trees, depletes the rocky slopes of their already sparse dusting of soil. The rate of change of erosion in concert with the rate of change of tree pollen deposition, therefore, speaks to relative changes in forest coverage over time.

In the Lake Kopais region of Boeotia, for example, soil and pollen deposits were analyzed by Turner and Greig following the coring of an exposed peat layer during the construction of a bridge, once in 1964 and again in 1968.[85] While pollen preservation was limited, they were still able to establish broad changes in forest coverage through the end of the Neolithic period. While there is a paucity of radiocarbon dates for these cores, the beginning of the latest phase, K7, was dated to 5205 $\pm$ 120 BP, bringing us into the Final Neolithic.[86] This date marks a critical juncture in the ecological history of the lake basin, as the fossil pollen record reveals a dramatic displacement of the open oak woodlands that covered the steep slopes around the lake since the beginning of the post-glacial period. Grasses and herbs sharply increase as oak pollen is reduced by half. Simultaneously, evidence of erosion and inwash from the surrounding hillside appears in the composition of the lake sediments, as clay replaces mud in this late period. A thin band of peat also appears, as a result of the influx of sediment and the subsequently shallower waters.[87] The removal of a critical number of oak trees around the lake could have, in this case, increased the rate of erosion, reduced the volume of soil on those slopes, and further made it more difficult for those species to recover their previous populations. Turner and Greig attribute the pronounced transformation of the local ecology to the demands of sustained human habitation.[88] Grazing animals, space-making for farming, and fuel requirements strained the delicate balance of the lake and its surrounding environs.

In the Argive plain, there is a large, fertile basin flanked by steep mountains that was home to many settlements since the Neolithic period including Lerna, Argos, and Tiryns. This plain was seasonally striped with migrating streams that deposited sediment from the mountains into the sea, forming a large alluvial fan and marching the coastline ever seaward since sea level rise stabilized and marine transgression ceased sometime after 2500 BC. Sometime during the Early Helladic period (EH II; 3rd millennium BCE), this landform saw massive flood plain deposits that were 1-3 m thick and

[85] Turner & Greig, 1975.
[86] Turner & Greig, 1975, p. 194.
[87] Ibid.
[88] Ibid.

constitute the majority of the Argive plain's current topography.[89] The reddish-brown alluvium held captive a preponderance of EH pottery, marking the event as both abrupt and dateable. Following this massive deposition, the contributing slopes stabilized and continued to maintain their integrity until later in the bronze age ca. LH IIIB. The soil that filled the basin "stripped the Pliocene marls and Pleistocene fans of the foothills along the eastern, northern, and NW margins of the plain of most of their brown woodland soils," a massive erosion event that rendered the plain fertile, habitable, and arable.[90]

The 1987 core taken at the ancient site of Lake Lerna by E. Zangger provided further details of this geological episode, as it illustrated the vegetation history of the area. Based on the pollen record, as above, the majority of the Neolithic period boasted dense deciduous oak forests, which became less diverse over time and more densely and purely populated with deciduous oak.[91] Towards the end of the Neolithic, ca. 3600 BCE, deciduous oaks declined suddenly and were replaced by pine (*Pinus*), which had been absent from the record until this point, and oriental hornbeam (*Carpinus orientalis*). Maquis species, such as *Quercus coccifera/ilex*, *Erica*, *Phillyrea*, *Cistaceae* (arrival of *Cistus salvifolius*) and *Olea*, seem to have begun to spread, indicating forest clearing.[92] This trend continued through the Early Helladic period, beyond 2500 BCE, as deciduous woody taxa decreased and evergreen maquis taxa came to dominate the landscape.

Forest clearing leading up to and throughout the EH period is evident and coincides with a period of population growth in the Argive plain. The synchronous erosion event that cast rich woodland soils off of the steep margins of the plain must therefore be understood as a consequence of the forest clearing indicated by the pollen record. The impact of this early human intervention in the forest ecosystem both at Lake Kopais and the Argolid Plain is extraordinary, novel, and permanent, because the combination of deforestation events, erosion, and the demands of feeding growing populations precluded these tree populations from ever recovering. Acknowledging anthropogenic factors in major geological events is, however, a more recent scholarly movement. Prior to the pioneering work of van Andel, Zangger, and Demitrack in 1990, the prevailing model for the alluviation of the Mediterranean was the Vita-Finzi model.[93] This framework dichotomized alluvial fill into two phases of erosion based on their color. The Older Fill, characterized by its redder colors, is claimed to have been deposited in the late Pleistocene (ca. 50,000–10,000 years BP), and the Younger Fill, which tends to be brown and gray, must have been deposited in the late Roman era (ca. AD 400), based on the archaeological material found in its matrix.[94] Both mega-events were, according to Vita-Finzi, the consequence of climatic factors. This model received criticisms and refinements,[95] but it wasn't until 1979, during the Argolid Exploration Project of Stanford University and the resulting

[89] Van Andel et al., 1990, p.384.
[90] Ibid.
[91] Jahns, 1993, p.195.
[92] Ibid.
[93] Vita-Finzi, 1969.
[94] For a summary of Vita-Finzi's model and its limitations, see Van Andel et al., 1990.
[95] Butzer, 1969; Davidson, 1971; Davidson, 1980; Eisma, 1964; Kraft et al., 1980; among others.

publications in the 1980s and 1990s, that the alluvial fill was convincingly attributed to human land use, among other factors.[96]

With this discovery in mind, rates of erosion and major erosion events are germane to the question of use and over-use of forest resources before and after the advent of palatial coercion on the Greek mainland. In combination with the pollen record and climate proxy data, geomorphological information links collective choice with its consequences and aligns the study area with the trends illustrated above, or not. Increased population pressure on the landscape, especially growth in a population engaged in industrial activities like metal smithing, ceramic production, and the accrual of agricultural surplus, that does *not* precipitate marked erosion events may be indicative of sustainable land use and a consensus about the limits of forest removal and exploitation.

Geomorphological studies have been conducted at ancient Pylos and the Bay of Navarino during the aforementioned PRAP survey. Previous studies in Messenia identified through survey the ranked soil zones of the southern Peloponnese[97] and their composition.[98] Zangger et al. focused their inquiry on four sub areas in the Hither Province, the seat of the Pylian kingdom, creating soil-landform maps with an eye towards measuring the probability that Bronze Age sites would be intact and thus identifiable through survey.[99] Here they recorded the underlying bedrock, landscape forms, landscape slope, and the nature of the soil.[100] Near the palace, on and below the Englianos ridge and its major port, the team took augur cores on the steep, eroded ridge of the Upper and the fertile floodplain of the Lower Englianos.[101] In combination with the macro-observations of the entire sub area, these cores bear traces of volume and periodicity of erosion events. Stratified cores reveal dumps of alluvium at various thicknesses topped by the formation of a soil layer, which manifests after the land has stabilized and once again becomes coated in decayed organic matter. If stability is never returned to the area, this soil layer never forms, and the stratigraphy of the alluvium is obscured.

The Osmanaga Lagoon cores, whose primary function is to yield fossil pollen grains, also tell a story about periods of soil stability and erosion. Organic matter in the layers of sediment have various levels of carbon (C) and nitrogen (N) depending on its source. Terrestrial biomass has, naturally, high carbon content, and its constituent cellulose and lignin have no nitrogen. Organic matter deriving from a marine environment, such as plankton, have a high nitrogen content because of their DNA and proteins.[102] Lower C/N ratios thus tend to reflect more marine input, and higher ratios result from more terrestrial input. The streams and rivers that empty into the lagoon carry sediment enriched with decayed plant matter. Massive erosion contributes thicker sediment strata in the lagoon along with an influx of carbon, thus raising the C/N ratio. The carbon and nitrogen content of these strata were measured and published in the PRAP II volume and bring greater clarity to the question of when and to what level of severity anthropogenic erosion took place near the Palace of Nestor in the Bronze Age.

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[96] Pope & Van Andel, 1984; Finke, 1988.
[97] Loy, 1970.
[98] Yassoglou & Nobelli, 1972.
[99] 2 km x 1 km zones in Metaxada/Kalopsana, Dialiskari, Upper Englianos, and Lower Englianos (Zangger et al., 1997).
[100] Zangger et al., 1997, pp. 560-568.
[101] Augur cores were taken at 10 m intervals perpendicular to the slope (Zangger et al., 1997, pp. 559-568).
[102] Zangger et al., 1997, p.589.

Beyond the presence or absence of erosion events, soil studies in the above mentioned cases also provide foundational data for the reconstruction of archaeological landscapes and agricultural potential. Soil composition combined with environmental and anthropogenic processes, such as river courses, geological formations, flooding, and proximity to the sea, govern the arable potential of an area and dictate the scale of labor investments in bringing it under cultivation. Loy's 1970 survey of the physical geography of Messenia is keystone in understanding agricultural potential in the Bronze Age, as he identified various degrees of soil quality/fertility in the region and induced the extent of anthropogenic changes that had occurred in the succeeding three millenia.[103] This, in combination with an examination of mineral weathering and soil ages from Crete, were the basis for the PRAP II soil survey in four key areas of western Messenia: Metaxada, Dialiskari, Upper Englianos, and Lower Englianos in which the quality, age, and composition of the soil was ascertained.[104] The variables here consist of bedrock depth and composition, water holding capabilities, natural topographical features such as slopes and cliffs, colluvial and alluvial contributions, salinity (possibly from sea spray), and acidity, and they were evaluated based on systematic augur coring and aerial photo reconnaissance.

1.3.4 *Modeling Demands on Forest Resources*

The use of proxy data to reanimate the movements and gestures of the Pylian palaeoenvironment reveals the delicate dynamics between human and plant communities. Layering palaeoclimatic, palynological, and geomorphological data brings clarity to outcomes of these interfaces and articulates the spaces in which human impact must exist. In a period of climate stability, synchronized episodes of deforestation and erosion are consequences around which the outlines of human agency and resource (over)exploitation can be traced. The question now turns to exactly those choices, and how appropriators exerted pressure on the common-pool resources in their local environment. This is ultimately a question of *practice* as it constitutes and accommodates *demand*. Here I have taken a three-pronged approach to Modeling Bronze Age timber and fuel use: a) demand as calculated by persistent behaviors and universal attributes, such as the pyrotechnic properties of kilns, the necessity of hearth fires for cooking/heating, and the melting point of various copper alloys; b) demand as calculated by temporally-bound behaviors that are particular to the region and period in question, such as ship building strategies, domestic and monumental architecture, and warfare; and c) extrapolation metrics that scale the behaviors appropriately for the context, which includes population and production extent data. The aggregate of these estimates gives a sense both of the function and scale of extractive practices, and in concert with the observable environmental *outcomes* the choices of the users comes into focus. *How* was demand met by the available resources, and *what* substitutions, work-arounds, and/or tiered access arrangements were implemented?

The persistent behaviors identified for the Messenian population are those that are resistant to change due to universal human needs and the physical properties of the resources themselves. To calculate the carrying capacity of a given territory, certain variables are constant: human beings require approximately 2000 calories of food per person per day, the morphology and ideal growing conditions

[103] Loy, 1970.
[104] Zangger et al., 1997, pp. 559-568; Timpson et al., 1996.

of cereals require a minimum of 0.86 ha of growing space to sustain a family of five,[105] and atmospheric moisture in the Mediterranean has extremely high interannual variability, which means families must account for significant crop loss. These are factors that have an influence over demand calculations completely divorced from chronological context, and as such they can be gleaned from ethnographic and anecdotal data. A foundational datum pertaining to yearly domestic fuel consumption comes, for example, from a survey of Greek families living in the Argolid in the 1970s, prior to the ubiquity of gas and electric heating/cooking systems.[106] Modern potters using a raw wood fuel system estimate that a typical 10-hour firing in a small kiln requires 250 kg of wood, while 19th c. lime producers in Dhidhima would typically use a staggering 100,000 kg (100 tonnes) of wood fuel *per firing*.[107] Elemental properties are also key in such calculations. Olive pomace cakes, for example, are 2.5 times more fuel efficient than raw wood, more available in Greek agricultural contexts, and more often used in modern ceramic production contexts.[108] In industrial contexts, moreover, raw wood can be used for combustion for the production of ceramics, glass, fulling, lime making, cooking, and the smithing and casting of bronze, silver, and gold, while those that require temperatures above 1100℃, such as metal ore refinement, are difficult to sustain without the use of charcoal or bellows. The properties and melting points of various copper alloys are also consistent and predictable, allowing us to easily estimate the fuel costs of smithing and casting activities.[109] Finally, while preference for wood *types* can be subject to cultural (TEK) or individual inputs, common knowledge about the physical properties of wood types naturally inform choice tendencies. The porosity of coniferous softwood, for example, makes it a weaker construction material and lends itself to high temperature but quick burning fires, and its sap content generates abundant acrid smoke. Olive wood is abundant in olive cultivation contexts but is oily, which makes it smoky and requires a longer seasoning time, and generally stays quite small giving it a smaller tree-to-firewood ratio.

Context contingent behaviors, on the other hand, can be much more difficult to ascertain, since they vary depending on technology, style, and custom. The basis for modeling idiosyncratic practices as they influence demand is archaeological evidence. For the sake of accuracy, it is important to take into account regionally specific conventions and technologies, however, sample size and bias often require extra-regional data in order to complete the picture. In Messenia in particular, domestic and monumental architecture in the Middle and Late Bronze Age is observable at a handful of sites. The Palace of Nestor on Epano Englianos and the Cyclopean Terrace Building (CTB) at Iklaina offer a consistent, if paltry, sample of (regional) monumental architectural conventions from the Late Helladic that bear large stone walls reinforced by pine and oak timbers.[110] Construction techniques here are consistent with palatial buildings elsewhere on the mainland that are more abundant and can even be cross referenced with *depictions* of walls on the painted frescoes that adorn them in turn.[111]

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[105] Netting, 1986, p. 70.
[106] Forbes & Koster, 1976, p. 122.
[107] Forbes & Koster, 1976, p. 126; Wertime, 1983, p. 450.
[108] Rowan, 2015; Veal, 2017b.
[109] Kaufman & Scott, 2014.
[110] Nelson, 2001; Cosmopoulos, 2021.
[111] Blegen, 1965; Blegen, & Rawson, 1966.

Given the archaeological bias toward elite spaces and marvels of human ingenuity, the humbler domestic spaces in Messenia and beyond have seldom been explored. A smattering of local habitation areas have provided some clarity, however the inter-site variability and less durable building materials make accurate estimates challenging. Nichoria, Malthi, and Iklaina are our main sources of information, though, aside from Malthi, all but the rings of stone socles have been lost to time.[112] Another costly context-contingent behavior is shipbuilding, though its traces are more obscure than even a Pylian's humblest home. Consequently, the data foraged for resource cost estimates forces one to look beyond the area of study, beyond even Greece and the Aegean, while temporal scope simultaneously narrows. Shipwrecks from the Bronze Age are limited to those at Uluburun and Cape Gelidonya, which were operational during the 14th and 13th c. BCE, respectively.[113] Hull fragments reveal construction strategies, technologies, and preferences, to an extent, and this narrow glimpse is broadened slightly through the addition of iconographic (i.e. painted ceramics, though mostly from later Greek contexts) and documentary evidence (papyri from Egypt listing prices of ship timbers).[114]

In order to extrapolate the scale of extraction, it is necessary to apply population and production metrics culled from archaeological, documentary, and survey data. Once again, the University of Minnesota Messenia Expedition (UMME) survey in the 1960s and the Pylos Regional Archaeological Project (PRAP) survey in the 1990s supply local settlement information, which consists of both the number of observed sites within the area of study and the estimated size of those sites through time.[115] There are certain biases that make these settlement and population distributions somewhat imprecise, however. Erosion and modern urban/agricultural interference impacts the visibility of sites under survey, obscuring both their size and their very presence, and without excavation the number of inhabitants at any one site can only be roughly estimated. McDonald and Hope Simpson warn that "some of our colleagues have... pressed us to avoid absolute [population] numbers entirely, since it is so easy for the most cautious estimates to become accepted facts."[116] Caveats aside, valuable patterns emerge thanks to the careful recording of the surveyors and the interpretive courage of McDonald and Hope Simpson, and consequently the *average* populations within individual settlements and the number of settlements in the region can be cautiously marshaled when considering the scale of extraction. The standard metric–or accepted range–for population estimates in the Bronze age employed here, 200-250 people per hectare, is consistent with those provided in other, later sources.[117] Such estimates are particularly pertinent in the context of domestic fuel consumption and the size of ceramic markets.

Similarly, market scale has a bearing on the reconstruction of the ceramic kiln fuel demand in particular, since, unlike the production of lime plaster or the smithing of metal objects, there would have been a constant and ubiquitous appetite for pottery. Beyond market size, however, pottery

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[112] Cosmopoulos, 2006; Cosmopoulos et al., 2019; McDonald et al., 1975; McDonald, 1972; Valmin, 1953; Worsham et al., 2018.

[113] Bass et al., 1967; Pulak, 1988; Wachsmann, 1998.

[114] Monroe, 2007; Monroe, 2010; Wachsmann 1998.

[115] Davis et al., 1997; McDonald & Hope Simpson, 1972.

[116] McDonald & Hope Simpson, 1972, p. 132.

[117] Broodbank, 2000; Whitelaw, 2001.

production had other pertinent social and economic dimensions; in earlier periods, particularly the late Early and early Middle Helladic (2200 - 1700 BCE), production was undertaken by more craftspeople on a part-time basis, while a smaller number of specialized, full-time potters accommodated the needs of later populations. This shift alters the demand model insofar as it informs the number of firings per kiln per year. Archaeological data from beyond Messenia underpins these estimates, since chronologically appropriate archaeological comparanda has been found only in a handful of places on the mainland.[118] The size, number, and distribution of kilns thus broadly informs the technological progression with respect to scale of ceramic production and the status of producers as economic agents. The final index of scale comes from the Linear B documents, which attest indirectly to two applications of timber use germane to this demand model: the minimum size of the naval fleet and the number of provincial centers likely to boast monumental architecture. While misfortune occasions neither a census nor a log of timber expenditures, these sparing records reveal incidental, oblique accounts of regional (administrative) centers and the conscription of hundreds of men for the purpose of rowing.[119] With these data we can infer the minimum number of ships in use at the time of the documents' composition (n=20) as well as a robust basis on which we might conjecture the number of large administrative buildings that would have withdrawn large oak timbers from the forest.

The contributions of Meiggs (1982) and his text-based approach to understanding wood-use are the progenitors of modern forest exploitation models in the ancient Graeco-Roman world.[120] As was customary for the time, Meiggs marshaled literary data in his reconstruction of extraction incentives and probed ancient legislation as he considered the timber trade, building contracts, and forest regulations. The temporal and geographic scope is impressive, but it also limits precision. Meiggs' survey of the data is decidedly–even defiantly–qualitative, eschewing more modern methodologies "in an age which worships quantification and statistics."[121] Instead, he proffers a comprehensive and meticulously assembled narrative with claims of scale substantiated by (reliable) anecdotal evidence, a marvel of textual synthesis and a natural springboard for further research.

Recently, a quantitative approach to calculating fuel and timber usage has been taken up by classical scholars working in southern Italy and in Mediterranean mining contexts in particular. Much like the methodology applied here, these projects are data-driven and stand on dual foundations: elemental attributes and culturally situated practices/technologies. Cypriot forest exploitation models, for example, draw out the environmental impact of copper ore extraction and refinement in particular, noting the fuel costs of mining, pre-roasting, and smelting the raw materials.[122] Based on the attributes of charcoal production, charcoal temperature potential, the ratios of surface forest/number of trees and number of trees/volume of wood, and the chemical composition of the copper ore on Cyprus, it

[118] Plasi, Lerna, Makrygianni, and Kirrha (Spencer, 2007; Day, 2004; Kapsali, 2019.
[119] Regional centers: PY Jn 829, PY On 300, PY Cn(2) 608, PY Vn 20, and the PY Ma series; conscription of rowers: PY An(4) 1, PY An 610, and PY An 724.
[120] Meiggs, 1982.
[121] Meiggs, 1982, p. 362.
[122] Constantinou, 1982; Constantinou, 1992; Stöllner, 2003; Svizzero & Tisdell, 2017.

has been estimated that a 5 kg ingot of copper would require 700 kg of wood for its production.[123] With such estimates, the environmental impact of mining can be approximated.

In recent years Robin Veal has endeavored to contextualize the political and economic stakes of timber and fuel acquisition in the ancient world, especially as it pertains to statecraft and power, and modeled fuel demand in urban settings. In many ways Veal takes on Meiggs' mantle, teasing apart the infinite complexities of urban life and tracing the social and practical aspects of wood procurement as a vector of scarcity, inequality, and diplomacy. Unlike Meiggs, however, she concentrates on the numbers and figures. Her methodology includes unpacking the calorific potential of various fuel types (including charcoal and olive pomace), charcoal analysis, and quantitative modeling taking into account the plant communities and productive potential (including climate) of the region in question.[124] Interestingly, in her quantitative economic model for fuel consumption, both as applied to 1st c. Pompeii and 2nd c. imperial Rome, Veal supplies an equation for calculating the forest acreage needed to supply a given population under the assumption that users are extracting sustainably:

POPULATION (a range of possible figures) X FUEL CONSUMPTION / FOREST PRODUCTIVITY, where
FUEL CONSUMPTION = (% RAW WOOD + % CHARCOAL) and
CHARCOAL = RAW WOOD X (EFFICIENCY FACTOR from 4 – 7):
(making a total of Raw Wood required for Charcoal production)[125]

She provides a range of results, accounting for high and low population estimates as well as low and medium forest productivity values (2 tonnes/hectare and 4 tonnes/hectare, respectively). Productivity here is estimated based on ethnographic data from communities with similar ecologies that slightly underutilize their forest resources at 2 tonnes per hectare. Given the soil quality and annual rainfall of her study regions, Veal places this figure at the low range, and 4 tonnes per hectare at the medium range of extractive potential. The assumed sustainable use practice is signaled by the preponderance of charcoal with a smaller diameter (likely branches) in domestic contexts, reserving trunks and larger diameter boughs for industrial purposes.[126] She suggests that beech was likely managed for fuel through a pollarding program, accommodating the slower growth of beech trees and staving off the threats of grazing animals to more delicate coppiced woodlands.[127]

In the context of Bronze Age Messenia, it is precisely this assumption that I wish to problematize and compare directly with the outcomes indicated in the pollen record. Here, we can't assume a convenient 2-4 tonne/hectare range for forest productivity, since it is necessary to first take appraisal of the use-practices. As such, rather than calculating total forest area required to sustain a given population, demand is calculated in a) tonnes of wood and b) number of whole trees felled. Under conditions where users are prone to unsustainable clear-cutting practices, this sum may reflect a much smaller area than that of a coppiced or pollarded forest.

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[123] Craddock, 1995; Pichler et al., 2013.
[124] Veal, 2012; Veal, 2013; Veal, 2017a; Veal, 2017b.
[125] Veal, 2012, p. 41.
[126] Veal, 2012, p. 42.
[127] Veal, 2012, p. 38.

1.3.5 *Documentary Evidence*

The final component of this project is the examination of the cultivated agricultural landscape, particularly as it relates to division, state extraction, and structures of ownership. As was discussed above, the sustainable stewardship of forest and agricultural land ought not be viewed as necessarily mutually exclusive, and in fact the institutions that govern lawful use of one may inflect or borrow from the other. As such, it is important to ascertain the characteristics of human engagements with cultivated/cultivable land and how the property arrangements accommodated the threefold demands of population growth, a burgeoning commodities market, and taxation extraction. While it is certainly possible that under these conditions the Messenians privileged the maximization of the territory's caloric output or the profits from an olive oil export market over their forest resources, replacing stands of trees with fields of wheat, it ought not be our baseline assumption. Rather, my objective is to articulate the many choices a community made when faced with resource exigency, how they balanced, or not, their subsistence needs, and whether there was institutional parity between the governance of forest and field.

With respect to land tenure, it could be argued that modern ontologies have been projected onto ancient communities. Relaki and Catapoti (1981) in *An Archaeology of Land Ownership*, for example, assert that we must destabilize the modernist paradigm that situates land as a passive object occupied and dominated by man, the center. Rather, this idea of individualist-capitalist-rational man was borne out of a particular moment in history when capitalism and the middle class were forming. There was a forced dichotomy between dwelling/use and ownership/subjugation. This twists our perceptions of the relationship between the human agent and land in the ancient world. They argue that Heidegger, rather, better captures the non-modernist view in which *Dasein* grounds people in a reciprocal relationship with their environment, where they engage in various ways of "producing something, tending to something and looking after it, making use of something, giving something up and letting it go, undertaking, accomplishing, interrogating, discussing."[128]

Modern assumptions about relationships to land permeate the study of Mycenaean land tenure. Ideas about ownership, alienability, profit maximization, and individualism have been seated thoughtlessly in the many opaque spaces of the records. To uncover the land use realities in Late Helladic Pylos it's important to peel away anachronistic readings of the PY E Series, the 184 Linear B documents discovered in the Palace of Nestor that deal with landholdings in the nearby settlements of *pakijane* and *ti-no*. What is difficult about the documents is that they are laconic and seem to include administrative jargon and esoteric titles. They include only the most salient pieces of information for palatial officials: names, titles, units of (land) measurements, and a handful of other unknown land/land-use designations. Additionally, Linear B syllabary was a writing system that was originally developed for another language, the language of the Minoans, but *adapted* for communicating in Greek. It awkwardly accommodates Greek's tangles of consonants and strings of vowels in a way that makes many readings of the same word possible.

[128] Heidegger, 1962, p. 83

The Linear B documents from Pylos were first discovered by C. Blegen in 1939 in an area of the palace that appears to have been an archive room, or archive complex near the entrance. Here, scribes collected data about palatial and provincial economics, the movements of goods in and out of the palace, on clay tablets. These tablets had several forms: smaller "leaf" tablets housed single entries, possibly information collected in the field as commodities were counted. Collections of single entries were subsequently grouped and rewritten on larger clay tablets called "page" tablets. A lot can be gleaned from the process of re-inscription, especially as changes in language and word order reveal important aspects of their administrative organization. For the land documents, for example, the term *ko-to-na* may be omitted from the smaller leaf entry, then added in the page tablet in line with the entry or in a header that applies to them all. The term, therefore, is implied, even when it is omitted. The verb *e-ke* (ἔχει, "has" "holds") often appears in the leaf tablets in an unknown form: *e-ke-qe.* These differences may be the result of different preferences of scribes collating and copying the leaf tablets into larger page tablets, though it is still unclear. Despite this careful recording method, none of the tablets, even the page tablets, were meant to be permanent, and the clay was likely reused at a given interval (monthly? seasonally? yearly?). Their survival was an accident of history, when the fiery destruction of the palace ca. 1200 BCE incidentally baked the clay, allowing them to survive for millennia.

In the landmark tome, *Mycenaean Documents,* Ventris and Chadwick made very well researched suggestions about how certain terms and certain categories of documents should be understood, and this historic contribution still grounds all scholarly inquiry pertaining to the documents.[129] It is no Linear B doctrine, nor was it ever intended to be one, but rather was the product of ongoing collaborative exploration. No reading is framed as absolute and true, and the book's glossary gives a road map for future inquiry. As the field of Mycenology evolved, however, certain suggestions, serving almost as placeholder terms so that meaning could be wrung from these inscrutable texts, were codified. When Mycenaean scholars began to explore complex economic systems and the organization of Mycenaean society, the placeholder terms *lease, private landholding,* and *mayor* biased scholarly reconstructions of property distribution and state functions. A private landholding assumes that communities in the LH III held the belief that land could be owned by an individual, as opposed to its use being an inherited, communal right. Accepting a leasing system adds another layer of complexity to ownership structures that allow some, but not others, to own land, and those who own land, rather than subsisting off of it, to *profit* from it. All of these hypothetical conditions may exactly correspond to the Mycenaean reality, but it cannot be assumed simply because we have tacitly allowed a modern, monetized, paradigm of ownership and profit to shape our interpretations. This is where the burden of proof exists.

My approach to the documents is threefold. First, I explore the relationships between certain terms and certain contractual agreements/obligations that are present in the PY E Series, synthesizing foundational interpretations of the document formula, etymologies, and the nature of the recorded transaction. Particular attention is paid to a) the demographic information about the named

[129] Ventris & Chadwick, 1973.

individuals, b) the obscure term *o-na-ta*, which is the focal point of the transaction, and c) the title *te-re-ta*, seemingly assigned to some but not all landed individuals.

Next, I interrogate the conventional reading of the series and the "leasing paradigm." While applying Cartesian doubt and stripping away modern assumptions about property and profitability, I offer a new reading of the Linear B land documents that takes into account the vegetation history and agricultural strategies that have long been sequestered in the provinces of other disciplines. This is fundamentally a landscape–and practice–based reading, and paramount to this approach is the integration into our analysis of farming practices that are specific to a) Greek landscapes, rainfall, and topography and b) a pre-mechanized world. Farming ethnographies are helpful in supplying this type of specific behavioral information. Robert Netting's 1986 *Cultural Ecology*, for example, illustrates concisely the form and function of human interventions in their environment and how these interventions accord with or diverge from convenient heuristic "hunter-gatherer" or "pastoralist"packages.[130] Important contributions come from his detailing of crop cycles and shifting versus intensive cultivation strategies, communal land arrangements, and the intersection between farming strategies and social organization. This survey of diverse modes of subsistence dispels convenient but misleading cognitive traps that fashion a vision of a one-dimensional farmer, pastoralist, or hunter-gatherer, allowing us to imagine mixed and variable subsistence strategies and their ecological and administrative signatures. While Netting culls anecdotal data from a variety of geographical contexts, Halstead's 2014 ethnography of early 20th c. farmers focuses on the peculiarities and limits of the Greek landscape.[131] Through his informative–as well as funny and endearing–conversations with elder Greek farmers, the reader comes to realize the diversity and customizability of landscape-specific practices employed; for example, farmers cultivating the wisps of thin soil streaking Messenia's rocky cliffs employ practices distinct from those who work the deeper, river-fed plains of the Argolid. Dimensions of wealth and poverty also are revealed to influence practices, as in some cases pairs of traction animals are only obtainable through neighborly relations, and resting even a small portion of one's field is a privilege belonging only to those with large enough properties.

With these practical nuances in mind, and combined with the reconstruction of the region's paleoecology, the transactions and players recorded in the administrative documents take new form. As such, institutional change and institutional friction come into sharper focus, particularly as evidenced by the attached obligations of landedness (both communal and private), the creation of indebtedness, and how privatization strategies marked the landscape.

[130] Netting, 1986.
[131] Halstead, 2014.

2. GEOGRAPHY, CLIMATE, AND VEGETATION IN WESTERN MESSENIA

2.1 *Modern Geography, Climate, and Vegetation*

2.1.1 *Geography*

Messenia is a region of the southwestern Peloponnese that occupies its westernmost peninsula and whose coastlines flank the Ionian sea. The northern boundary of the modern province is marked by the Alpheios river, and Mt. Taygetos demarcates its eastern edge. The province directly abuts Lakonia to the southeast, Arcadia to the east, and Elis to the north. Long and narrow, the region measures approximately 62 miles north to south and 31 miles east to west at its widest point. The region comprises a westward projecting peninsula that is bordered by the Gulf of Kyparissia on its north coast and the Gulf of Messenia in the southeast.



Figure 2.1 Map of Peloponnese, Messenia in box.



Figure 2.2 Map of Messenia with major features labeled.

This peninsula is home to the Bay of Navarino, the geographic focus of this project, which was formed 9,000 years ago.[132] The bay itself faces west and is partially enclosed by a narrow island, Sphaktiria, which grants access to the bay in only two places: the narrow Sykia channel in the north (approximately 200 m at its narrowest point) and to the south is a wider opening, which measures approximately 1200 m at its narrowest point. Thucydides describes these openings in terms of ship's lengths, citing:

[132] Zangger et al., 1997, p. 557.

> ἡ γὰρ νῆσος ἡ Σφακτηρία καλουμένη τόν τε λιμένα παρατείνουσακαὶ ἐγγὺς ἐπικειμένη ἐχυρὸν ποιεῖ καὶ τοὺς ἔσπλους στενούς, τῇ μὲνδυοῖν νεοῖν διάπλουν κατὰ τὸ τείχισμα τῶν Ἀθηναίων καὶ τὴν Πύλον, τῇ δὲ πρὸς τὴν ἄλλην ἤπειρον ὀκτὼ ἢ ἐννέα" (Thucydides, iv.8.6).[133]

As the bay exists now, it measures 10 km north-south and 4 km east-west, however, in the early Holocene the bay likely extended 5 km further north but was filled in with alluvium.

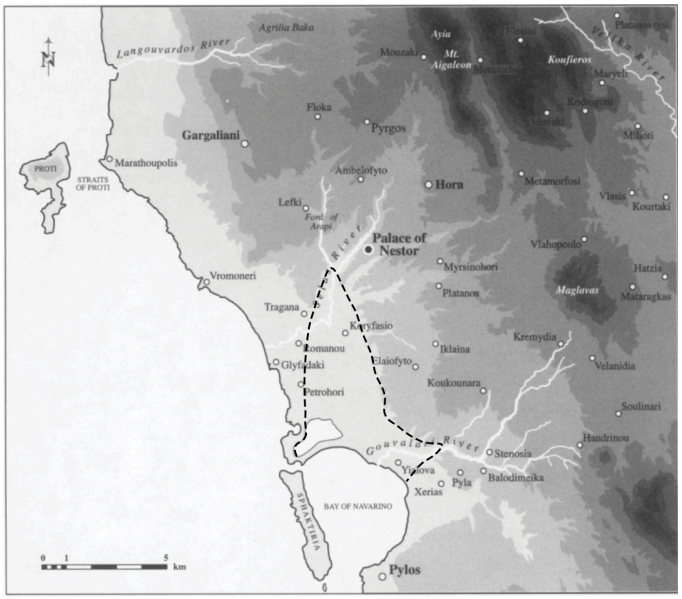


Figure 2.3 Map of the Bay of Navarino with a dotted line marking the alluvial fan that filled in the northern 5k of early Holocene bay (adapted from Zangger et al., 1997, fig. 2; dotted line added by author).

At the base of this floodplain, at the northern end of the bay and 9 km southwest of the Palace of Nestor, there existed a crescent-shaped lagoon that cupped the northern end of the bay and stilled the trapped water from the hill-borne streams in placid refuge. A sandbar and the palaeonavarino ridge insulate this feature from the Ionian sea. It is here where pollen was captured for millennia, gently settling on layers of alluvium and marking the area's vegetative history in its fine stratigraphy. The lagoon and the alluvial fan, however, index incongruous geological phenomena.[134] The alluvial plain must have been the result of a north-south running river that emptied into the bay on its northern coastline, yet the extant, persistent lagoon signals a cessation of such silting process. Currently the Gouvalari River, running east to west just north of Yialova, and the Xerias River, running east to west just south of Xerias, empty freshwater into the western shore of the bay, however, there is no surviving river that would have deposited such a volume of alluvium at the north of the bay. If one had existed in the bay's recent history, moreover, it would have certainly continued depositing sediment and eventually filled the lagoon. This anomaly has led some scholars to suggest that the Selas river, which now runs west and empties into the Ionian sea, north of the Bay of Navarino, must have at one point run south, emptying into the northern part of the bay and creating the large alluvial fan.[135] Given that a sharp westward diversion was interpreted as an unnatural course, and the modern river cuts through a man-made canal between Agios Dimitrios and Romanou, both Kraft et al. (1980) and Zangger et al. (1997) posit the idea that this was the result of human engineering undertaken in order to cultivate and inhabit the floodplain. Based on the age of the lagoon, which formed no later than 800 BCE, and the magnitude of the labor cost and organization, this river diversion may have been the accomplishment of the Pylians in the Late Bronze Age.[136]

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[133] See Bauslaugh, 1979 for a discussion on the erroneous nature of these measurements.
[134] Zangger et al., 1997, p. 613.
[135] Zangger et al., 1997; Kraft et al., 1980.
[136] Zangger et al., 1997, pp. 613-623.

The bay belongs to a narrow coastal plain that stretches all the way to the province's northern boundary. East of this plain elevations rise as the land ascends into a series of mountain ranges that occupy the majority of the region. South of the Alpheios River, the Minthi Mountains give way to the Tetrazi Mountains, divided by the east-west running Neda River. At the base of the peninsula, Mt. Psychro and the Kyparissia mountains, Mt. Aigaleion, Mt. Psoriari, and Mt. Ithomi rise in long ribbons stretching southward, cut by the rivers emptying into the Ionian sea and the gulf of Messenia. In the west the Selas and the Gouvalari slice the submontane area west of the Mt. Aigaleion and Mt. Manglavas into finger-like ridges and deep river valleys. One of these ridges, the Englianos Ridge, is home to the Palace of Nestor. East of the Kyparissia Mountains, around the Gulf of Messenia, two rich agricultural zones are connected by the Pamisos River: at the coastline the lower Messenian Plain, often called μακαρία[137] "blessed," and to the north the upper Messenian plain, also known as the Στενυκληρικὸν plain is completely enclosed by mountains and is separated from the lower plain by a series of low hills, the Skala, which run west-east almost continuously from Mt. Ithomi to the Taygetos Mountains. The Pamisos and myriad small streams irrigate these fertile plains and make them famous for their fecundity. The eastern boundary of the region lies in the Taygetos Mountains, which divide Messenia and Laconia.

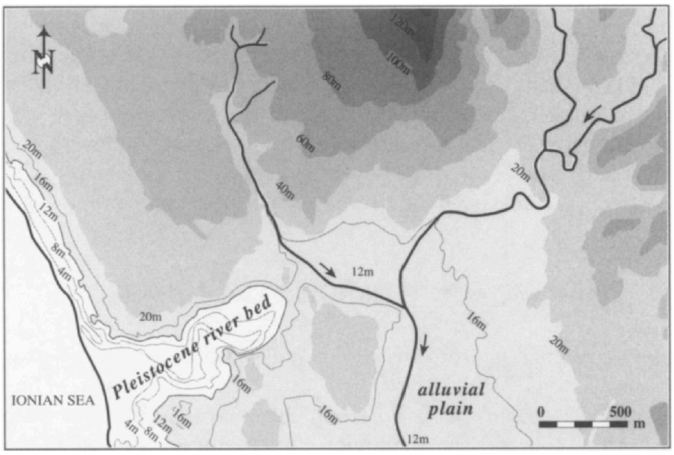


Figure 2.4 Reconstruction of the course of the Selas River during the Early Holocene (Zangger et al., 1997, fig. 41).

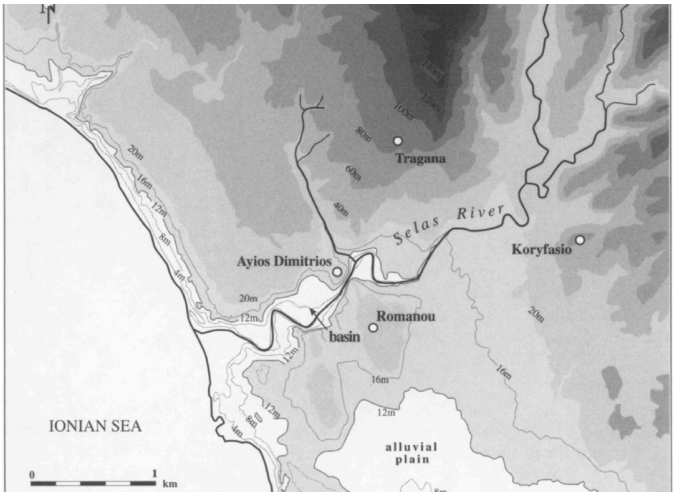


Figure 2.5 Present day topography between the Palace of Nestor and the Ionian Coast (Zangger et al., 1997, fig. 42).

2.1.2 *Climate*

Messenia has a typical Mediterranean climate characterized by dry, hot summers and wet, moderate winters. The dominant airstream that brings both moisture in the winter and hotter air currents in the summer develop in the west and move eastward, affecting the climate on the western

[137] From *Strabo* viii.4.6.

coast of the Peloponnese especially.[138] As these winter weather systems move west over the Greek mainland, they will often get ensnared in the mountainous area in the central Peloponnese, which thus forms a kind of rainfall barrier. Messenia sits on the windward side of this barrier and is therefore saved from the deprivation of more eastern regions of Greece, and its mountainous central zone, though lower in elevation than those in, say, Laconia or Arcadia, mimics these same patterns. As the moisture-bearing clouds move into terrain at higher elevations and are snagged by its peaks, they deposit substantially more rainfall. In general the area receives a mean annual rainfall between 750 and 1000 mm, less than 15% of which materializing in the summer months.[139] The winters in coastal areas are mild, remaining frost-free with an average winter temperature of 5-10°C. In most of Greece the summer is long and dry, lasting up to 5 months and remaining almost entirely rainless for the duration. During this period temperatures can rise to more than 25°C in the western Peloponnese.

The most distinctive feature of the Mediterranean climate is the interannual variability in precipitation. Long periods of summer drought may or may not yield to compensatory levels of rainfall during the winter months.[140] This requires that plants adapt to such uncertainty by initiating a summer dormancy as a drought defense.[141] Such extreme variability exercises both ancient and modern farmers alike. Especially dry or wet years can have catastrophic effects on the crops of dry-farmers; staple crops such as wheat require 50-75 cm of rainfall per year, a quota difficult to reach in many places in Greece, and the topography of the area makes it particularly vulnerable to erosion from periods of heavy rainfall.

2.1.3 *Vegetation*

Modern Messenia is a patchwork of small grain, olive, grape, currant, and fig farms that are dry-farmed or well irrigated by the many springs that form seasonal rivers emanating from the naturally favorable mountain catchment areas.[142] Given the relative abundance of water resources and the fertile river valleys, Messenia has a much higher proportion of arable land than the rest of Greece on average. Towards the end of the 20th century, 40% of Messenian land was classed as arable, a high water mark for Greece in general, which has an average of 28% of land classed as arable. The once dense forests of the mountainous central area of the province is now confined to the uplands of the Taygetos Mountains and occupy only 15% of the area's land.[143] The degradation of the evergreen and mixed

[138] Polunin, 1980, pp. 14-18.
[139] Ibid.
[140] Loy et al., 1972, pp. 37-40.
[141] Polunin, 1980, p. 17; irrigated areas in modern Messenia are not abundant but occur in the Pamisos River Valley, along the Alpheios and Neda Rivers, on the eastern coastline of the Bay of Navarino, and in small pockets in the southeastern Tetrazi Mountains (from pocket map 11-20 in McDonald et al., 1972).
[142] Loy & Wright Jr., 1972, pp. 42-43.
[143] Ibid.

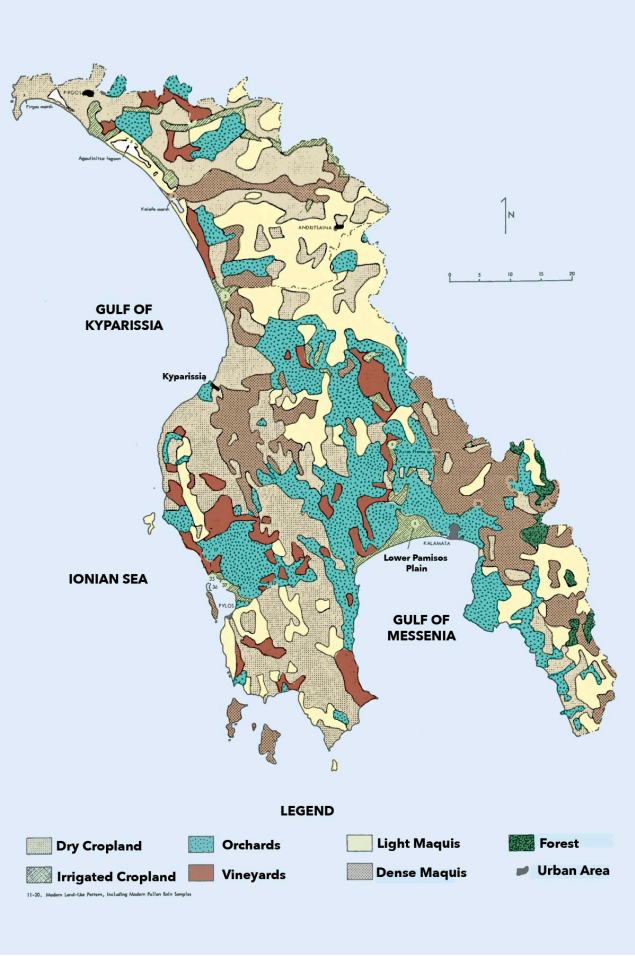


Figure 2.6 Map of Messenian vegetation zones ca. 1970 (adapted from van Wersch in McDonald and Rapp 1972, pocket map 11-20)

deciduous forests results in maquis,[144] phrygana,[145] and pseudo-steppe[146] environments, which cling to the non-arable slopes and stony uplands.

The degraded state of the Messenian environment is the natural result of millennia of extreme exploitation. Every inch of arable land has been utilized, and the hills have been cleared and terraced. What cannot be planted has been cleared of forest cover and used in some areas for animal grazing, presenting now as degraded maquis or phrygana environments. Deforestation has catalyzed severe erosion and transformed the region's mountainous landscapes into less hospitable crags, where thin wisps of soil can no longer accommodate dense forests. The current state of landscape ought not, however, be expected at all periods of Messenian history, especially at the time of its first human settlements. Rather than a treeless and heavily eroded farmscape, early populations would have been

[144] Maquis: A tall dense scrub often 2-3 m high, largely composed of hard-leaved evergreen shrubs, with a very characteristic collection of associated species. Maquis may result from the clearing of the dominant trees, or may represent a local climax vegetation in its own right. Further degrades into phrygana. Characteristic species: *Pinus halepensis, Juniperus phoenicea, Quercus coccifera, Quercus ilex, Laurus nobilis, Cercis siliquastrum, Calicotome villosa, Spartium junceum, Cotinus coggygria, Pistacia lentiscus, Paliurus spina-christi, Cistus incanus, Cistus salvifolius, Myrtus communis, Arbutus unedo, Arbutus unedo, Erica arborea, Erica manipuliflora, Phillyrea latifolia, Olea europaea, Rosmarinus officinalis, Phlomis fruticosa, Globularia alypum, Asparagus acutifolius, Ruscus aculeatus, Smilax aspera.* (verbatim Polunin, 1980, pp. 35-36)

[145] Phrygana: the most widespread dwarf scrub vegetation of dry slopes, hills, and islands in the Mediterranean climatic zone. It tends to occur in drier climates and has a greater preponderance of small shrubs and shrublets with leathery leaves, often spiny branches, commonly densely gray-hairy, and frequently aromatic. It is maintained in a relatively stable state by grazing, fires, and selective cutting by man. Phrygana forms from degraded maquis populations. Characteristic species: *Quercus coccifera, Sarcopoterium spinosum, Genista acanthoclada, Anthyllis hermanniae, Anthyllis tetraphylla, Euphorbia acanthothamnos, Thymelaea tartonraira, Thymelaea hirsuta, Hypericum empetrifolium, cistus incanus, Cistus salvifolius, Satureja thymbra, Globularia alypum, Fumana thymifolia, Thapsia garganica, Teucrium polium, Teucrium brevifolium, Lavandula stoechas, Phlomis fruticosa, Ballota acetabulosa, Micromeria juliana, Origanum onites, Helichrysum stoechas, Phagnalon rupestre, Pallenis spinosa, Asphodelus aestivus, Urginea maritima, Muscari comosum*. (verbatim, Polunin 1980, p. 37).

[146] Pseudo-steppe: Occurs in the hill and lower mountain regions where the soil has been washed away, usually as a result of overgrazing and clearing, thus exposing the bedrock. The list of typical pseudo-steppe species is too long to list here.

greeted by sprawling deciduous and evergreen forests and fertile soils: the *natural potential* of the region.

According to phytosociology, the natural potential plant communities of an area typify the *climax* phase of vegetation cover. Based on the level of precipitation a region receives, the quality of its soils, and its geology and landforms, one can anticipate discrete plant communities to thrive. The field of phytosociology, developed by Josias Braun-Blanquet and adapted to Greece by Horvat et al. and Polunin, maps these plant communities, termed "syntaxa," and develops a scheme that arranges them, both spatially and hierarchically, as it marks the phases or steps in a plant community's development from pioneer species to established communities to less diverse, degraded plant populations, most often the result of anthropogenic disruptions.[147] They posit, for example, that evergreen woods (a climax syntaxa) can degrade into maquis, then phrygana, then pseudo-steppe by various means (human interference, fire, drought, etc...). Depending on the region, Maquis may also be a climax of sorts, which, again, may degrade into the above mentioned states.

Evergreen woods (climax) ⇌ Maquis ⇌ Phrygana ⇌ Pseudo-steppe[148]
Maquis (climax) ↗

According to phytosociological convention, these zones take the name of the dominant characteristic plant species or pair of species, in the case of compound names, but code important ecological information that takes into account species composition, structure, cover, and distribution of all the composite species within the community. In this study the *climax* phase of each plant community will be mapped, rather than the current, early, or degraded phases, in order to illuminate the natural *potential* vegetation of each region, serving as a control against which the human-plant interface appears in higher relief. Based on the geology, topography, and climate of western Messenia, therefore, the qualities of the potential mature plant communities must be extrapolated, divorced from its current phyto-composition under agricultural and arboricultural exploitation.

According to this hierarchical classification scheme, Messenia is comprised of three discrete zones: the Oleo-Ceratonian zone along the southern coastal plains (0-200 m.a.s.l.), a Quercion ilicis zone (and Andrachno-quercelum sub-zone) along the coastal plains in the north of the region as well as in the submontane areas of the south (200-500 m.a.s.l.), and a Quercian frainetto (with a Quercetum frainetto-brachyphyllae subzone) at the highest elevations on Mt. Lykodimo and the Kyparissia mountains and the Aigaleion ridge (500-1500 m.a.s.l.).[149]

[147] Braun-Blanquet, 1964; Polunin, 1980.
[148] Polunin, 1980, p.36.
[149] Jahns, 1993; Horvat et al., 1974; Polunin, 1980.

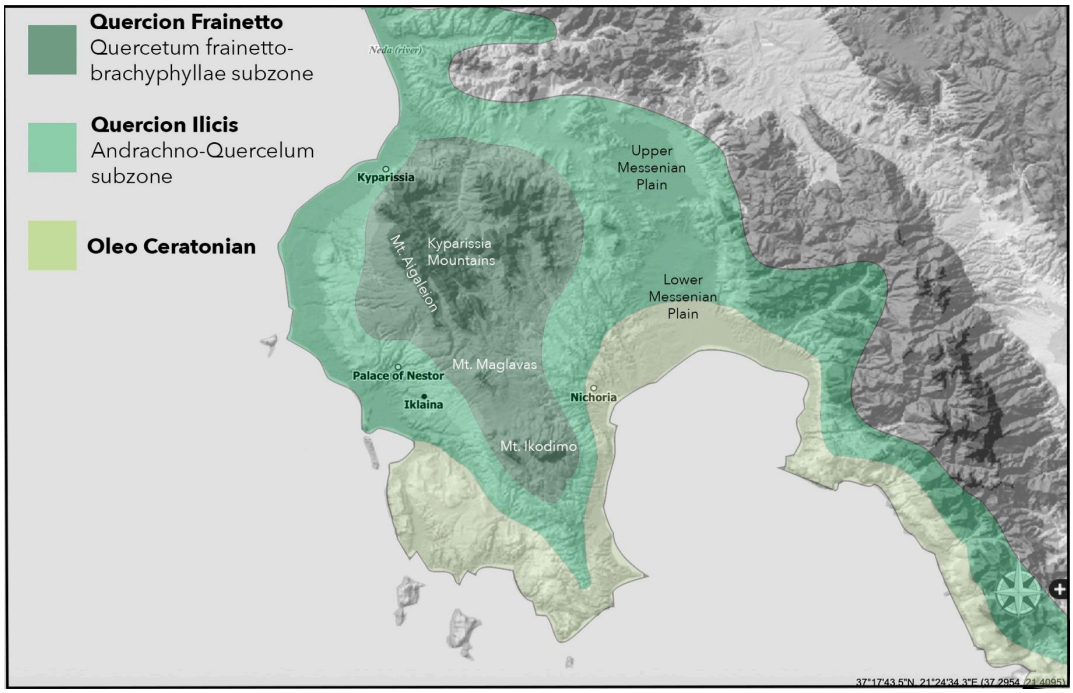


Figure 2.7 Map of Peloponnese marking the vegetation zones in Messenia (adapted from Jahns, 1993; Horvat et al., 1974).

The coastal Oleo-Ceratonian alliance, expressed in Figure 2.7 with light green fill, is characterized by xeromorphic plant species that are extremely drought tolerant and sensitive to frost. Typically this community will thrive in areas with low annual rainfall (3-6 cm), high temperatures (mean temperature 17°C), and are most common in coastal regions from 0-500 m.a.s.l..[150] As is suggested by the nomenclature, the dominant tree species are the wild olive (*Olea europaea*) and the carob (*Ceratonia siliqua*) as well as the mastic tree (*Pistacia lentiscus*). Woven into the understudy of this community of drought resistant trees, other evergreen shrubs will likewise appear, including the evergreen kermes oak (*Quercus coccifera*), myrtle (*Myrtus communis*), buckthorn (*Rhamnus alaternus*), and butcher's broom (*Ruscus aculeatus*), among others.[151] Low rainfall demands that most plants in this community remain quite shrubby and low to ground, however, in accordance with the phytosociological hierarchical scheme, this alliance represents the climax of such thermoxerophyllous scrub adapted to sandy and/or saline coastal soils. It is, however, vulnerable to anthropogenic degradation as well as fire.[152]

In the sub-montane regions of Messenia another potential ecology would have naturally prospered: the Quercion ilicis zone and the Andrachno-quercelum subzone, expressed in Figure 2.7 with green fill. At these higher elevations (up to 900-1100 m.a.s.l., but typically between 300 and 800

[150] Jahns, 1993, p.189.
[151] *Juniperus phoenicea, Calicotome villosa, Pistacia terebinthus, Phillyrea latifolia, Salvia triloba, Phagnalon rupestre, Smilax aspera, and Asparagus aphyllus* are all commonly associated with this syntaxa (Polunin, 1980, pp. 32-33).
[152] Polunin, 1980; Gianguzzi & Bazan, 2019.

m.a.s.l.[153]) this type of habitat receives more atmospheric moisture and moderate temperatures.[154] As a result, the more drought resistant species that dominate the lower coastal areas do not thrive, especially in the Andrachno-quercelum alliance. Evergreen forests composed of sclerophyllous[155] tree species are typical in these habitats and are most commonly distinguished by the preponderance of holm oak (*Quercus ilex*), which is tolerant of sandy soils and salty sea air. Conditions for abundant growth maintain a closed canopy that sustains only a thin understory. Competition for light favors the holm oak, which can grow in full shade, but little else, making this ecosystem one which boasts the least plant diversity. Pine trees (*Pinus halepensis*), mock privet (*Phillyrea latifolia*), prickly juniper (*Juniperus oxycedrus*), Greek strawberry tree (*Arbutus Andrachne*), and buckthorn (*Rhamnus alaternus*) are common especially in the Andrachno-quercelum subzone. Degradation of this plant community is most often the result of a drop in precipitation and/or human interference, namely the harvesting of wood and the grazing of animals. The outcome of such degradation is a sparse phrygana landscape.

At the higher elevations (450-900 m.a.s.l.), expressed in Figure 2.7 with forest green fill, on the interior of the peninsula, the third potential plant community, the Quercion frainetto association, would have been sustained by precipitation between 6.5 cm and 12 cm in a sub-humid climatic zone with long summers, mild winters, and a 1.5-2.5 month dry spell.[156] These thermophilous[157] forests prefer slightly alkaline soils of a sandy-loam texture with few stones and are typified by the dominance of the Hungarian/Italian oak (*Quercus frainetto*), a very large deciduous oak species. Cooler Quercian frainetto forests share the canopy with the Dalechamps oak (*Quercus dalechampii*), while warmer climes more frequently foster an interface with white oak (*Quercus pubescens*). According to Horvat et al. (1974) there are few complete lists of the plants belonging to this community, however it has been noted that it is generally poor in shrubs but rich in eagle fern (*Pteridium aquilinum*).[158] Forest devastation in southern Greece has been cited as the source of difficulty in reconstructing this plant community dominated by deciduous oak species.

2.2 ***The Outline of Pylian Control in Messenia***

In the Mycenaean period the area controlled by Pylos at its height was likely somewhat smaller than the modern province of Messenia, although its boundaries have long been debated. The geography of the Pylian Kingdom at the time of the destruction that shepherded the palace's ephemeral clay documents into the annals of history, LH IIIB ca. 1200 BCE, has been reconstructed based on a handful of documents. These documents, littered with toponyms, personal names, and titles, convey little information pertaining to the arrangement and configuration of their entries, however, since the 1970s, much work has been done to extract information about settlement and

[153] Horvat et al., 1974, p. 112.
[154] Jahns, 1993, p.189.
[155] Sclerophyll: evergreen plants with leathery leaves and short internodes especially adapted to long periods of aridity.
[156] Konstantinidis, 2002.
[157] Thermophilous: plants that prefer warmer climates.
[158] Horvat et al., 1974, p. 239.

boundary locations from what little survives.[159] The first, most important organizing principle of the kingdom's geography comes from PY Ng 319, PY Ng 332, and PY Wa 114, which contain a version of a word with the suffix *-a₃-ko-ra-i-ja*. This suffix appears to be some sort of geographic marker, dividing the kingdom into two provinces whose distinction exists in their relative relationship to it. It has been suggested, based on Messenian geography and the spelling of the toponym, that this boundary between provinces is, in fact, Mt. Aigaleion, which is positioned at the west of the Kyparissia Mountains.[160] Not only is this the western boundary of an imposing mountainous area that sweeps southward along the center of the peninsula, but it is also that which is closest to the Palace of Nestor, the other geographic marker against which all other localities are positioned. Each of the two terms begins either with *de-we-ro-* or *pe-ra₃-*, which are interpreted as δεῦρο "hither" and πέρα "beyond, further," respectively, so marking the hither and further provinces in reference to a) Mt. Aigaleion and b) the Palace of Nestor, the seat of the Pylian administration.[161]

The northern and easternmost boundaries of the territory are somewhat less clear and have been largely extrapolated based on the imagined arrangement of the sixteen place names listed in PY Jn 829, PY On 300, PY Cn(2) 608, PY Vn 20, and the PY Ma tablets, as well as the so-called *o-ka* tablets (PY An 657, 654, 519, 656, 661). PY Jn 829, PY On 300, PY Cn(2) 608, PY Vn 20, and the PY Ma tablets list the names of settlements according to the province to which they belong, as is specified in PY On 300, and remain consistent, for the most part, across all of the documents. The arrangement of these lists indicates that there are nine settlements, not including Pylos (*pu-ro*), in the Hither Province and seven settlements in the Further Province, not including Leuktron (*re-u-ko-to-ro*),[162] that are administratively relevant to the state.[163] It is difficult to place these toponyms, and thus the frontiers of the kingdom, in space. Pylos (*pu-ro*), Kyparissia (*ku-pa-ri-so*), and Rhion (*ri-jo*) have been satisfactorily correlated with the Palace of Nestor on the Englianos ridge, modern Kyparissia south of the Kyparissia River, and a southern cape of the peninsula known as Koroni (ῥίον in Greek means "cape" or "prominantory"), respectively, while the presence of *ke-re-wa* and *ka-ra-do-ro* on the "coastguard" tablets place them on the coast of the Hither province.[164]

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[159] See Bennet, 1995; Bennet, 2008; Chadwick, 1963; Chadwick, 1972; Chadwick, 1973; Cosmopoulos, 2006; Nakassis, 2015; Palmer, 1963; Shelmerdine, 1981; Shelmerdine, 2011.

[160] Chadwick, 1972, p.104.

[161] Chadwick, 1972, p.104.

[162] Chadwick has posited that Leuktron is the administrative center of the Further province and has thus been omitted, like Pylos, from the aforementioned tablets. This inference is buttressed by the distribution of enslaved women recorded in the PY Aa series, which allocated the majority of this labor force in the Hither province to Pylos (and *ro-u-so* as a subsidiary center) and to *re-u-ko-to-ro* in the Further province. This, Chadwick argues, makes Leuktron comparable, though subordinate, to Pylos in its respective district (Chadwick, 1972).

[163] PY Jn 829 lists contributions or distributions of bronze to local officials, the *ko-re-te* and the *po-ro-ko-re-te*; The *o-ka* tablets register companies of men deployed to various places along the coast as "coastguards"; PY Cn(2) 608 obliges settlements in the hither province to fatten a certain number of pigs; PY Vn 20 lists distributions of wine to nine settlements in the hither province; the PY Ma tablets are tax assessments, recording the quantity of commodities contributed by settlements in the Hither and Further provinces.

[164] Chadwick, 1972, p.110

Comprehension of the distribution of these settlements within each province is dependent upon the comprehension of the administrative conceptual organization of the territory. The list of settlements does not appear to be arranged by order of spelling,[165] yet the consistency in the sequence of place names betrays a uniform organization. It has been suggested that the list moves from north to south along roads emanating from the capital, Pylos, based on the presence of ri-jo, the cape at the south of the peninsula, being listed last. It is difficult to reconstruct the spatio-graphic structure, especially given the fact that the scribes were undoubtedly working from the palace proper, situated midway along the north south axis of the Hither province. Were it so that conceptualizations of the territory produced a sequence of settlements along this vertical axis, which is possible due to the fact that the provinces' very limits are shaped by landmarks with the same orientation, then one would naturally place the settlement of *pi-*82* as the kingdom's northernmost possession. It is unclear where this settlement existed. According to the University of Minnesota Messenia Expedition (UMME) survey in the 1960s and the Pylos Regional Archaeological Project (PRAP) survey in the 1990s at least 120 mycenaean (LH I-IIIB) sites have been identified in the modern province of Messenia, and Bennet estimates 247 place names have been recorded in the Linear B record in some manner.[166] Matching archaeological site to recorded attestation proves almost impossible given the volume of data and the opaque rationality behind the places listed on the various tablet series.

The location of the northern frontier must thus be inferred from the natural limits and barriers of the landscape. It has been generally accepted that the either the Tetrazi Mountains or the Neda River served as such a limit in the north, though the marginal landform that defines the northern contour of the Pylian state is a choice determined by modern assumptions about mountains and rivers as barriers to or conduits for connectivity and communication.[167] Whether it was the mountain range or the river that mitigated the state's northward expansion, the border rests significantly south (~25 km) of its modern placement on the Alpheios River. The Further province requires a similar calculation, since the north-south organizing principle cannot be so easily applied. There are various routes from Pylos to the interior of the peninsula, and a settlement (*ti-mi-to a-ko,* possibly τιρμίνθων ἄγκος, "glen of the terebinth trees"[168]) that is known to be coastal from the *o-ka* tablets does not appear at the end of the standard list, as would be expected based on the position of the Messenian Gulf coastline with respect to the rest of the Hither province. Moreover, it is the extent of control along this gulf coast that is in question, since the Taygetos Mountains form a natural, continuous border with Laconia (to this day). The Nedhon River (not to be confused with the Neda River in the north) at the northeast of the Messenian Gulf serves as a likely threshold for the Further frontier. The river cuts down from the Taygetos Mountains and empties into the gulf near modern Kalamata. While the river is not mentioned in the fixed list of seven settlements in the Further province, it is the destination for a company of men distributed to the coastline for the purposes of defense in the *o-ka* tablets. More

[165] The Linear B script is a syllabary and would not have means of alphabetical organization, however there is a dearth of evidence that points to any form of syllabic organization.
[166] Bennet, 2008, p. 151.
[167] See Purcell, 2017 and Purcell, 2012 for a detailed account of the political territoriality of these features.
[168] Palaima, 2000.

specifically, in PY An(3) 661 thirty men from *a_2-ka-a_2-ki-ro* and Olympia (*u-ru-pi-ja-jo*) are sent to the Nedhon River (*ne-do-wo-ta-de*).



Figure 2.8 Topographic map of Messenia featuring the possible provincial boundaries.

2.3 *Vegetation, Climate, and Habitation History: a diachronic view*

Speleothem data from the Mavri Trypa cave on the island of Schiza off the coast of western Messenia allow us to reconstruct the hydro-climatic context of the study area with a fairly high resolution during the period of the stalagmite's growth (2700 – 1000 BCE).[169] The rate of growth and the stable isotope composition of the accumulated minerals are a proxy for larger meteorological patterns, and wetter and drier periods can be mapped. Veiled by these larger year trends is the interannual variability that must thus be assumed in all of the discussions below. The overall picture of local subsistence is one of tenuous stability.

[169] 1-25 years with a mean of 6 years per sample (Wieberg and Finne 2018)

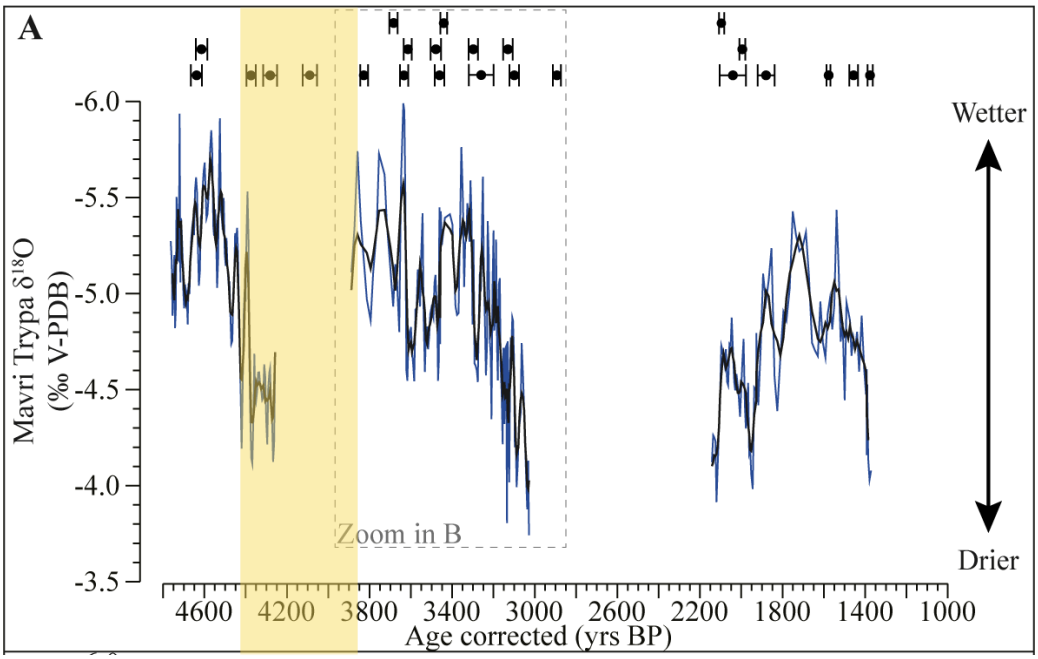


Figure 2.9 Rainfall indicated by $\delta^{18}O$ levels present in speleothem transect from Mavri Trypa cave on the island of Schiza. Highlighted portion is the period of increased aridity, with a hiatus in growth occurring between 4200 and 3800 BCE (selection from Finne et al., 2017, fig. 4a; highlighted by the author)

2.3.1 *Neolithic and Early Helladic ca. 6000-2200 BCE*

During the earliest period of growth, between 2700 and 2500 BCE, the stalagmite reveals a period of relatively high rainfall. Growth is consistent and $\delta^{18}O$ levels fall between -4.9 and -6.0 percent. Marine sediments from the southwestern Aegean likewise record a warm, humid phase during the mid Holocene. Subsequently, rainfall decreases precipitously until 2200 BCE when the formation ceases to grow altogether for approximately 400 years. This hiatus is likely the product of significant, long lasting aridity in the region, which is a possibility further sustained by evidence of a far reaching climate event that resulted in a period of drought in the beginning of the late Holocene elsewhere in the Mediterranean at the same time, commonly referred to as the "4.2 event."[170] The event appears to have been abrupt and severe and is marked by a "reduction of low saline Black Sea surface water influx into the Aegean indicat[ing] larger-scale changes in the climate system."[171] Aridity may have crept up into the southern parts of Italy, as the pollen data signals substantially diminished tree cover.[172] Tree ring data in Israel[173] and Syria[174] corroborate this trend, exhibiting a period of aridity between 2550–1750

[170] Finne et al., 2011.
[171] Kuhnt et al., 2008.
[172] Magri, 1999; Di Rita & Magri, 2009; Giraudi et al., 2011; Sadori et al., 2011.
[173] Frumkin, 2009.
[174] Fiorentino et al., 2008.

yrs BP. The cause of this climate "anomaly"[175] has been oft debated, however it is still not clear exactly what was the impetus.

In western Messenia the record of pollen deposition likewise takes a hiatus in the mid-Holocene. In the period between 5420 and 2000 BCE the accumulated sediment in Osmanaga Lagoon was a mere 70 cm; this is approximately 1 cm of sediment per 48 years, a dramatic divergence from the later rate of 1 cm per 5 years. The sediment itself is a silty sand, and intact pollen grains could only be recovered from 3 strata. Zangger et al. (1997) attribute this paucity to the texture of lagoon bed, which was coarse and inimical to the delicate grains.[176] Not only do the small pollen grains fail to accumulate among the larger sediment particles, but the deposition of sand typically results from a "high energy depositional environment,"[177] making the pollen susceptible to damage and destruction mechanically. From what remains the small samples illustrate a spell of significant pine tree coverage ca. 5500 BCE, with pine pollen representing 70% of the sample. The remainder of the sample boasted very low numbers of deciduous oak pollen , pistacia (mastic: *Pistacia lentiscus* and terebinth: *Pistacia terebinthus*)[178], strawberry tree, tree-heath, cistus, asphodel, and chenopods. Pine is clearly the dominant species, however it is important to put these data in context. Pine pollen is often much more durable than other types of pollen and has the ability to travel much greater distances. The pollen from the complete suite of taxa living in the Osmanaga catchment area may not have survived, and thus this early phase in the local ecology is biased towards its pine population.

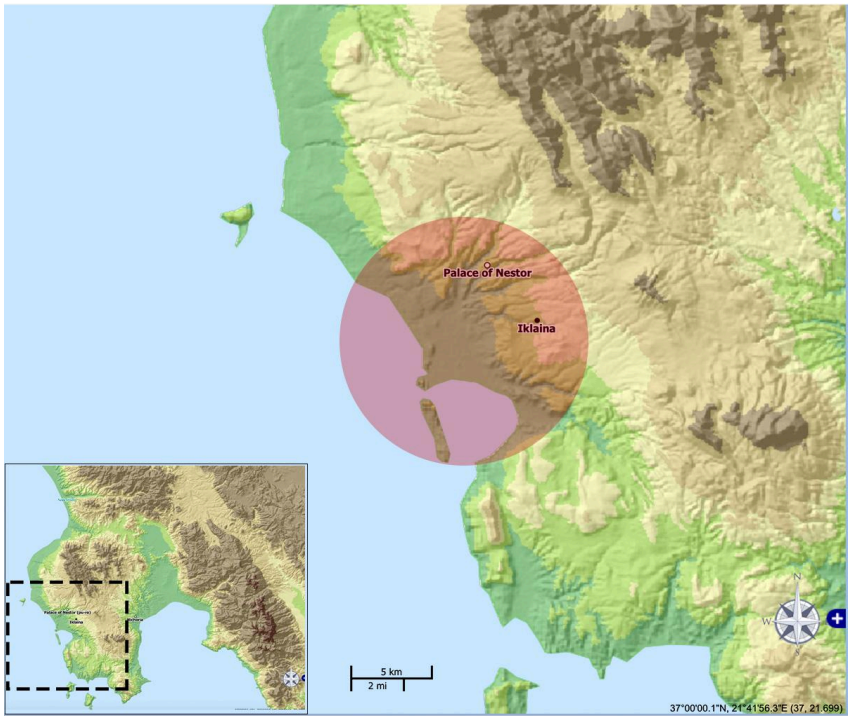


Figure 2.10 Osmanaga Lagoon pollen catchment area.

Towards the top of this sandy stratum superior preservation renders a more complete vision of vegetation ca. 2500-2100 BCE.[179] In the earlier sample, ca. 2500, pine pollen drops by 40%, while

[175] Finne et al., 2011.
[176] Zangger et al., 1997, p. 588.
[177] Ibid.
[178] Pollen sums from **mastic** (*Pistacia lentiscus*) and **terebinth** (*Pistacia terebinthus*) are combined.
[179] Dates are approximations based on the C14 dates of 5420 BCE at 470 cmbd and 2000 BCE at 415 cmbd.

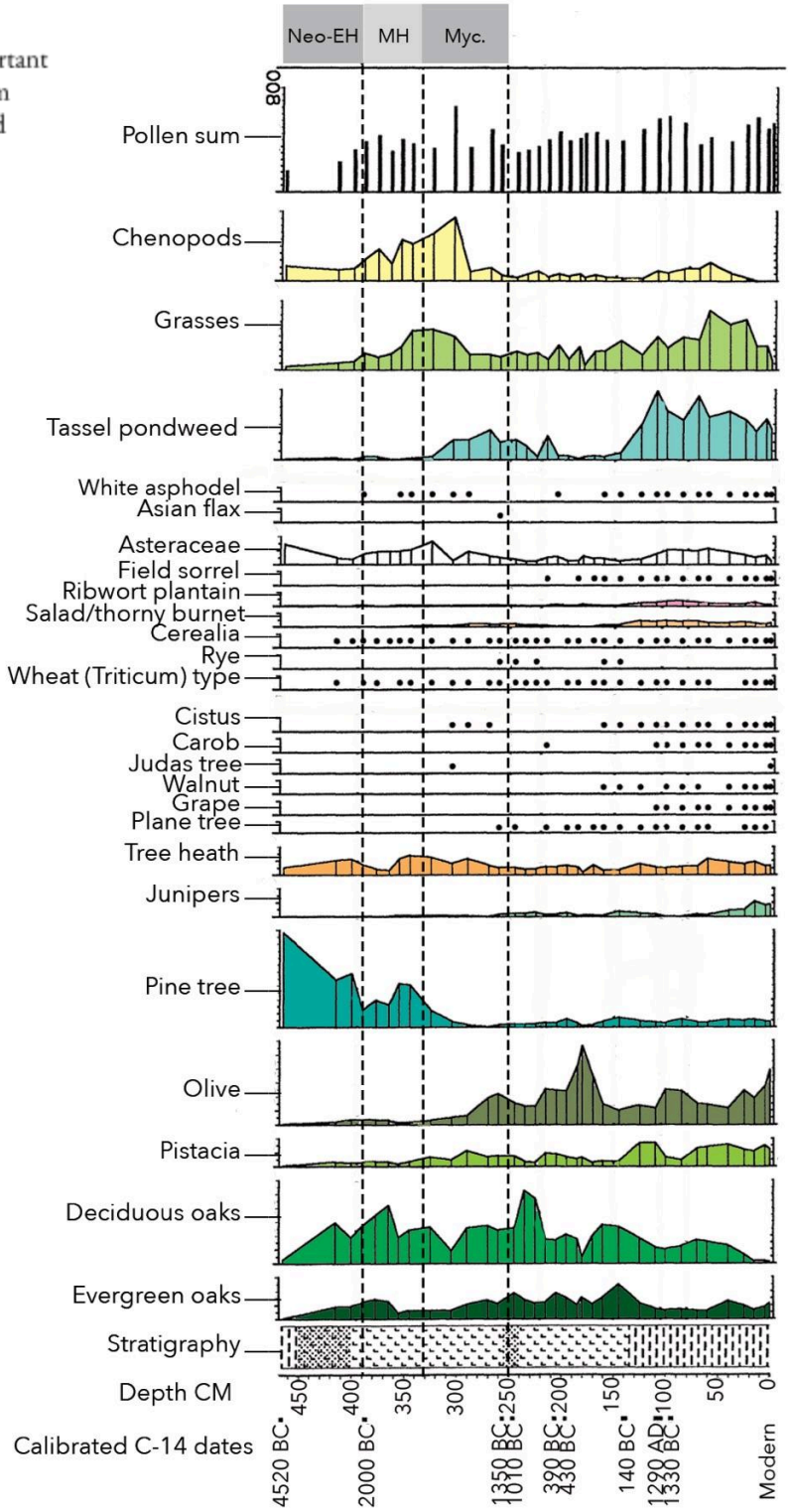


Figure 2.11 Selection of the most important pollen types from core D-4 (adapted from Zangger et al., 1997, fig. 24; colorized and reoriented by author).

deciduous oak populations appear to grow dramatically. Zangger et al. note that, due to the durability of the pine pollen, the living populations at this time were likely even lower than what is intimated by these numbers. Evergreen oak and tree-heath values each increase, and grasses and chenopods comprise the remainder. This stratum also contains the first appearance of wheat (*Triticum* spp.). In the later sample, ca. 2300 BCE, these proportions largely hold. Proportions of evergreen oaks, tree-heath, grasses, and chenopods pollen are maintained, and pistacia and olive remain present in low numbers. Pine increases by about 5% while deciduous oak decreases by the same amount. It is possible that this is the first sign of human intervention; if the deciduous oak population is reduced, possibly as a result of their high-value wood or as a result of clearing space for agriculture, pine pollen is afforded a larger proportion of the overall sample. The change, however, is quite subtle and may be attributed to nonidentical depositional and/or preservation environments.

The climatic shift in question, the 4.2 event, must be folded into the reading of the palynology, especially in light of these contemporaneous changes in vegetation. So dramatically did the atmospheric moisture diminish that the growth of the stalagmite at Mavri Trypa, just off the coast of the southwest Peloponnese, entirely stalled for four centuries. Likewise the growing conditions for plants would have been challenging if not completely inhospitable to taxa that require more rainfall. Oaks, while typically considered relatively resilient in arid climates, have been shown through recent research about the ecological consequences of the period of extreme drought in California between 2012 and 2015, the most severe drought to hit the region for at least 600 years, to have suffered.[180] The hardiness of these trees was tested throughout California,[181] and even well established, centuries-old trees struggled and began to exhibit bazaar defects such as the growth of miniscule leaves and extreme off-seasonal shedding, which ultimately led to death. Prolonged drought likewise depletes the groundwater, since aquifers are never suitably replenished from rainfall and snowmelt. Those trees growing at higher altitudes, on ridges and stony cliffs, are more easily disconnected from these sources of water and suffer more acutely. It can thus be inferred that the oak forests, especially those growing beyond the coastal basin around the Bay of Navarino, would have endured massive depopulation around 2200 BCE. Indeed the evidence supports the veracity of this theoretical outcome.

During the periods with the lowest available moisture (2600-2100 BCE; the highlighted portion in Figure 2.9), there is a marked decline in the oak pollen, at which point the pine, tree-heath, and juniper pollen increase. Based on the combined climatic and palynological data, it appears that a sustained drought, preceded by increasingly arid conditions disrupted oak growth (either by catalyzing defects that made them less palynologically visible or by causing widespread death). In their stead grew the hardier Aleppo pine, juniper, and tree-heath. This first major transformation of the vegetal composition can convincingly, therefore, be attributed to a unique climatic event, rather than human interference.

As we near the end of the epoch, around 2000 BCE, local vegetation is dramatically transformed. Pine (*pinus*) and tree-heath (*erica arborea*) populations plummet (-25%) while the percentages of grass, chenopod, and strawberry tree pollen double. Ribwort plantain (*Plantago lanceolata)*, yarrow (*Achillea millefolium*), and white asphodel (*Asphodelus albus*) appear for the first time. In aggregate these changes index landscape modification, wherein the expansive pine forest that once bent around the sandy coast and clung to the marl slopes of the uplands, dominating the pollen record in the pollen catchment area (PCA), was greatly diminished. Given the excursive behavior of the pollen grains, the actual pine coverage likely decreased even more than the 25% evident from the core, possibly as much as a 40% reduction, since those trees much farther afield likely contributed additional, perceptible quantities of pollen to the sample. In their stead grew taxa fond of open meadows and heathland (*Asphodelus albus, Plantago lanceolata*), phrygana, and semi-steppe shrubland (*Sarcopoterium spinosum, Erica arborea*) environments. This transformation will be termed **Deforestation Event 1** (DE 1)

[180] Osuna et al., 2015.

[181] Observations were made at the Blue Oak Ranch Reserve eas of San Jose, the Pepperwood Preserve in Sonoma County, and a private ranch in San Luis Obispo (Osuna et al., 2015)

2.3.1a *Scenario 1: Clearing for grazing/agriculture*

This particular combination of vegetation is often interpreted as marking human interference and, indirectly, the advent of agriculture. The arrival of asphodels and ribwort plantains in particular is suggestive of disruptive human practices, such as tilling and grazing hoofed animals, since both species thrive in disturbed soils. Two interesting variables, however, challenge this anthropogenic reading of the changes in vegetation. Drought tolerant maquis species, such as thorny burnet (*Sarcopoterium spinosum*), tree heath (*Erica arborea*), strawberry tree (*Arbutus unedo*) and evergreen oaks (*Quercus ilex, Quercus coccifera,* among others), become much more abundant. Human subsistence practices are suggested by the reduction in tree cover (clearing for grazing/agriculture) and the flourishing of plants that prefer open steppe environments with disturbed soil, and there exists archaeological survey evidence that indicates a scatter of Early and Middle Helladic settlements (**EH**: 3100-2000 BCE; **MH**: 2000-1690 BCE) in western Messenia.

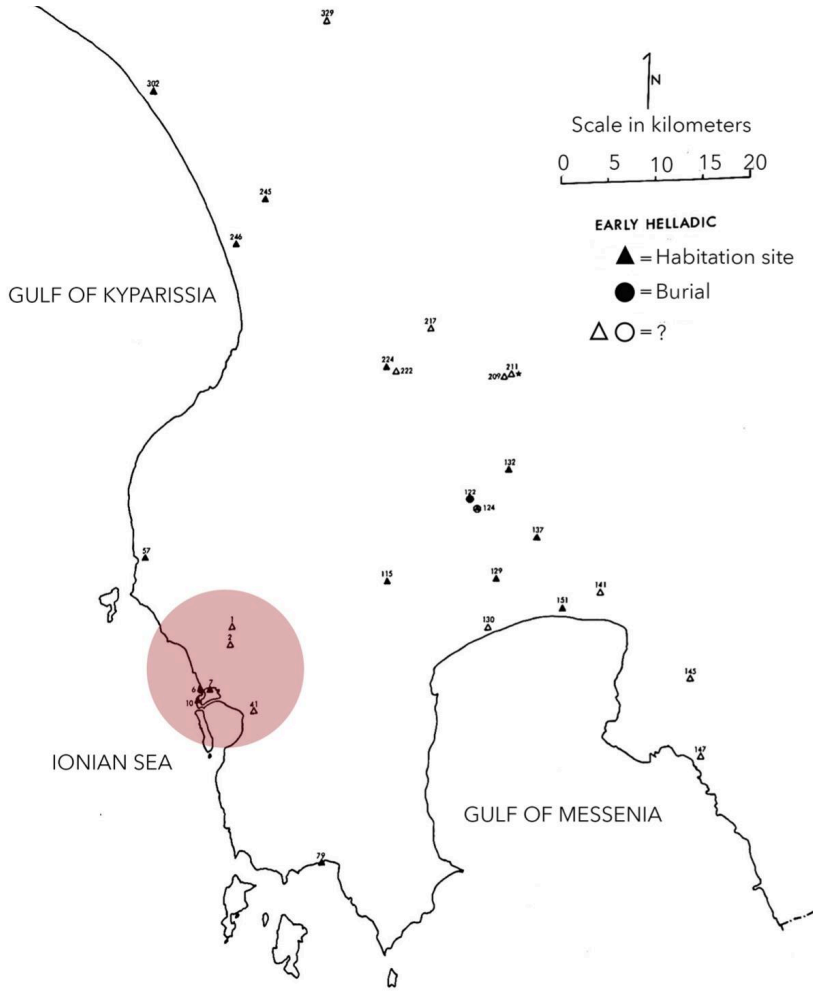


Figure 2.12 Early Helladic settlement and burial distribution in Messenia. Circle indicates Pollen Catchment Area (PCA) (adapted from McDonald & Hope Simpson, 1972, pocket map 8-12).

These settlements are sparse and small, however, and there appears to be limited evidence of widespread continuity beyond EH II ca. 2400 BCE, with the exception of Gargalianes *Ordines* near what would later become the Palace of Nestor, and four artifact clusters identified in field survey nomenclature POSI (place of special interest) B7, D1, I1, and K1.[182] Newly developed Middle Helladic sites, broadly defined, also have been identified, and appear to have been more numerous than

[182] Davis et al., 1997, p. 419.

EH terminal and EH continuous sites. This list includes Metaxada *Kalopsana*, Tragana *Voroulia*, Maryeli *Koutsouveri*, Gargaliani *Ayia Sotira*, and Valta *Kastraki*.[183]

Interestingly, the phases that boast the lowest densities and most scanty archaeological evidence, EH III-MH I/II (2200-1800 BCE), overlap almost exactly with the term of severe aridity in the 4.2 event. During this period the carrying capacity[184] of the region would have declined significantly, as crops (wheat in particular) and livestock would have been difficult to sustain in any great number with such scarce available moisture. Populations may have atomized and scattered in order to stake out a productive corner of the landscape, and as a result the area of study in western Messenia would have been markedly depopulated. Therefore, while certainly there was a detectable human presence at the moment of interest just before 2000 BCE, it is unlikely that they would have labored to clear large agricultural tracts or grazing places. Forest clearing for agriculture and livestock is a practice that maximizes the caloric output of a circumscribed area that has a *higher* carrying capacity; the land must be able to support more exploitation to be exploited more intensely, and this enterprise would have been undertaken in order to serve larger, more densely populated communities. Based on the climatic evidence, therefore, this is the least likely explanation for sudden disappearance of pine forests and tree-heath populations.

Moreover, the deciduous oak is delicate and difficult to establish when threatened by grazing or competition for nutrients, water, and sunlight. Were the hooves of sheep and goats agitating the newly cleared meadows to the delight of the asphodels and ribwort plantains, then the deciduous oak shoots would have been readily consumed and would never have formed stable, flourishing populations. The fact that this sudden change in the vegetation cover catalyzed a steady expansion of deciduous oak growth, starting at this point at +15% then increasing steadily for the next 200 years, attests to an ecology unencumbered by the appetites of animals and people.

2.3.1b *Scenario 2: Deforestation due to drought*

Were these plant population changes in DE 1 the result of increased aridity, as is suggested by the pervasiveness of hardy, drought tolerant maquis, then the decline in local pine stands ought not to have been affected. The Aleppo pine, common in warm climates and resilient in very arid conditions, would be a natural candidate to succeed during such a climatic shift. The pattern revealed by the pollen core is therefore particularly confounding, since neither human nor climatic impact can explain every fluctuation.

According to the speleothem data, the return of pre-drought atmospheric moisture levels comes ca. 1900 BCE, so theoretically this particular moment falls within, if at the tailend, of the 4.2 event. The prevalence of drought tolerant plants reflects these persistently arid conditions, and there appears evidence of a higher diversity of taxa, particularly among those that prefer open grass and shrublands. The striking, abrupt depletion of pine and tree heath stock clearly facilitated the spread of maquis and grasses. Deforestation made space for these plants to repopulate the newly cleared and

[183] Ibid.

[184] Carrying capacity: the number of people, other living organisms, or crops that a region can support without environmental degradation.

insolated forest floor. The cause of this change, however, is obscure. The pines and tree heath had survived the drought up until that point without catastrophic outcomes, thus the climatic conditions cannot convincingly be attributable to such a decline.

2.3.1c *Scenario 3: Deforestation due to selective exploitation*

It is possible that we are observing the silhouette of human action. Perhaps pine were exclusively selected for felling, either for the purposes of construction, fuel, or both, and for the next two centuries (2000-1800 BCE) this preference suppressed any population recovery. As a result, the highly competitive deciduous oak could monopolize the sun exposure, soil nutrients, and moisture that the pine forests no longer dominated. Timber/fuel selection would have been highly specific and unchanging, since oak populations steadily increased without interruption during this same period. Its value as construction material and the source of hot, long-lasting fires, in this scenario, would have been wholly subordinated or ignored.

This explanation would also necessarily suggest some variety of human population increase or the massive intensification of construction projects. We would expect more and larger settlements with evidence of fuel-burdened manufacturing (e.g. ceramics, metal objects, lime plaster) and/or massive building projects. However, direct evidence (i.e. ceramics detected by the UMME and PRAP surveys) of human population growth at the end of EH III is meager. In fact, as was mentioned above, there is a dearth of human detritus in the surveyed areas during the EH/MH transition. Some sites, such as POSIs I20, I28, and M1, appear to have been abandoned ca. EH III (2000 BCE) and Romanou *Romanou* shrank considerably at this point, though it later rebounded.[185] In conjunction with this decline in direct evidence of human occupation is the decline in the carrying capacity of the land indicated by the proxy data.

There is, moreover, a sister phenomenon that sits awkwardly within this narrative, the decline of tree-heath populations. This taxon will often grow in gnarled crags and sand dunes, so had every opportunity to flourish in this area of western Messenia, on the sandy shores of the Pylos and between cracks in rocks in the marl ridges. It is a flowering shrub-like tree that can grow up to 21' high but most often remains quite squat. This growth habit gives its wood few practical functions; its branches are wiry and irregular, and it has the unique property of being heat resistant, making its root burl ideal for pipe making. Under the conditions of this exploitation-selection model, a correlated decline of tree-heath cannot be explained. Humans engaged in intensified timber exploitation would not have likewise selected this plant variety for fuel wood or construction material.

2.3.1d *Scenario 4: Forest fire*

As has been evident on the west coast of the United States in recent years, warmer temperatures and lower rainfall has desiccated the landscape and made it particularly vulnerable to being consumed by wildfires. When there is enough precipitation to facilitate the maintenance of vegetation cover but

[185] Davis et al., 1997, p. 419.

not enough to prevent overdrying, fires can spread to a devastating degree.[186] Based on a fire history reconstruction of the western United States from 500 CE - present, Marlon et al. (2012) argue that before European settlement in the west in the 1800s CE the primary predictor of frequent burning events was climate. According to their statistical model, temperature was responsible for half of the biomass burning, and drought accounted for ⅓ of it overall.[187] Between 500 CE and 1500 CE population growth was relatively stable, climbing steadily, but moderately prior to contact with Europeans. Periods during which burning spiked were characterized by higher temperatures and lower precipitation, rather than higher populations, thus undermining an anthropogenic explanation.[188] Yearly precipitation patterns affect the duration of fire season and high temperatures during fire season "promote fire-conducive weather and lightning ignitions."[189] Likewise on a decadal or centennial time-scale, drought and higher temperatures increase the frequency of fire events and the total burned biomass.

Centuries of dry conditions in western Messenia (and the Mediterranean more broadly) provide a robust predictor of greater burned biomass, either due to frequency of wildfires or the more extensive spread during each episode. The Pylos region was primed for a spike in fires at the moment DE 1 occurred, and its impact on the vegetation supports the idea that a major burning event catalyzed it. The pollen evidence indicates that there was consistent vegetation cover throughout the pollen catchment area, around the Bay of Navarino, ca. 2000 BCE, so there was enough atmospheric moisture to support plant life, albeit that of predominantly drought tolerant species. Yet we know that precipitation was low, and the landscape plant cover would have been parched. The Aleppo pines and tree heath, while capable of surviving these arid conditions, would not have been moist enough to resist burning once a fire was ignited. At this point the sprawling pine forests and clusters of shrub-like trees would have burned indiscriminately, and in their place grew grasses, cereals, and chenopods.

2.3.1e *Discussion*

Support for the veracity of Scenario 4 appears in the geomorphological record. During this episode there is increased erosion evinced by higher C/N ratios (30, up from 5 in the previously tested stratum ca. 400 cmbd), which indicates an influx of terrestrial organic material accruing in the lagoon.[190] This spike in the C/N ratio cannot be attributed to stable C levels with sudden loss of nitrogen, since the N levels remain relatively stable throughout the Bronze Age. It is, rather, the carbon that is elevated at this time. Not only was the sedimentation increased and infused with carbon of terrestrial origin, but this 15 cm thick stratum is also permeated with charcoal. Evidently, DE 1

[186] Marlon et al., 2012, p. 535.
[187] Marlon et al., 2012, p. 539.
[188] After European settlement in the western United States, however, this pattern changed: "Human impacts on forest fires in the western United States since Euro-American settlement are well documented and primarily resulted from altered ignition patterns associated with land and debris clearance, agriculture, fire suppression, and fire exclusion more broadly. Grazing and the introduction of nonnative species had major impacts on a host of ecological processes that affect fire, including forest composition and structure, nutrient cycling, soils, and hydrology." (Marlon et al., 2012, p. 536).
[189] Marlon et al., 2012, p. 536
[190] Zangger et al., 1997, p. 589.

destabilized the soil around the bay and prompted a massive erosion event that filled the lagoon with charcoal-rich sediment.

This constellation of features preclude the possibility of DE 1 being the result of intentional human intervention (forest clearing for agriculture and grazing, felling for fuel or timber) or a response to aridity alone. The geomorphology demonstrates that the period of heightened erosion was coupled with more frequent or more extensive burning. The loss of pine *and* tree heath makes selective exploitation much less likely, especially in combination with the fact that both human populations and the carrying capacity of the region fell at this time. Prolonged drought conditions, while they greatly impacted the vegetation patterns and composition, could not have necessarily induced a massive forest die-off, especially given the moisture requirements of the pine and tree-heath. Finally, the oak population boom could not have occurred if the clearing of the forest were achieved for the purposes of creating space for grazing and/or agriculture, since deciduous oaks are intolerant of grazing.

2.3.2 *Middle Helladic ca. 2200-1700 BCE*

In the early stages of the Middle Helladic (MH) period in Messenia the drought carried on and inhibited any growth of the Mavri Trypa stalagmite. This continued aridity is consistent with evidence from elsewhere in the Mediterranean,[191] where the 400 year drought comes to a close ca. 1800 BCE ±100 years. Fortunately for the MH Messenians, atmospheric moisture rebounded to pre-drought levels on the earlier side, ca. 1850 BCE. For the subsequent ~300 years $\delta^{18}O$ levels remained between -5.0 and -6.0 (less negative values indicating less moisture), indexing a prolonged period of relatively high annual rainfall. One could expect plant growth to recover and greater crop yields as a result. At the end of the Middle Helladic, ca. 1700 BCE, moisture levels dropped but remained higher than the drought threshold.

After the fire(s) at the end of the EH, the vegetation underwent approximately 100 years of asymmetrical recovery. Core sample sediments from 390-370 cmbd became predominantly silty, signaling greater input from the Selas River, and contained increased quantities of evergreen oak pollen (+50%), pistacia (+50%), grasses (+60%), and chenopods (+60%). The most striking recovery, however, appears to have been accomplished by the deciduous oak, which doubled its pollen distribution in the Osmanaga Lagoon from the quantity of pollen recovered from the stratum that corresponds with the period of drought before the fire(s) (+100%). The asymmetry in this episode of regrowth is most pronounced in the faltering populations of pine (-60%). Tree heath likewise fails to return to pre-fire populations (-50%).

The final century of the harsh drought conditions, ca. 2000-1850 BCE, fostered a landscape in western Messenia dominated by mixed deciduous and evergreen (such as the *Quercus ilex*, the namesake of the syntaxa to which the pollen catchment area belongs) oak trees, between which a thriving understory of sclerophyllous shrub species, likely evergreen oaks such as the kermes oak (*Quercus coccifera*), grasses, and herbs emerge. As the deciduous oak population increases, it replaces

[191] See Section 2.3.1 for a discussion of the 4.2 Event.

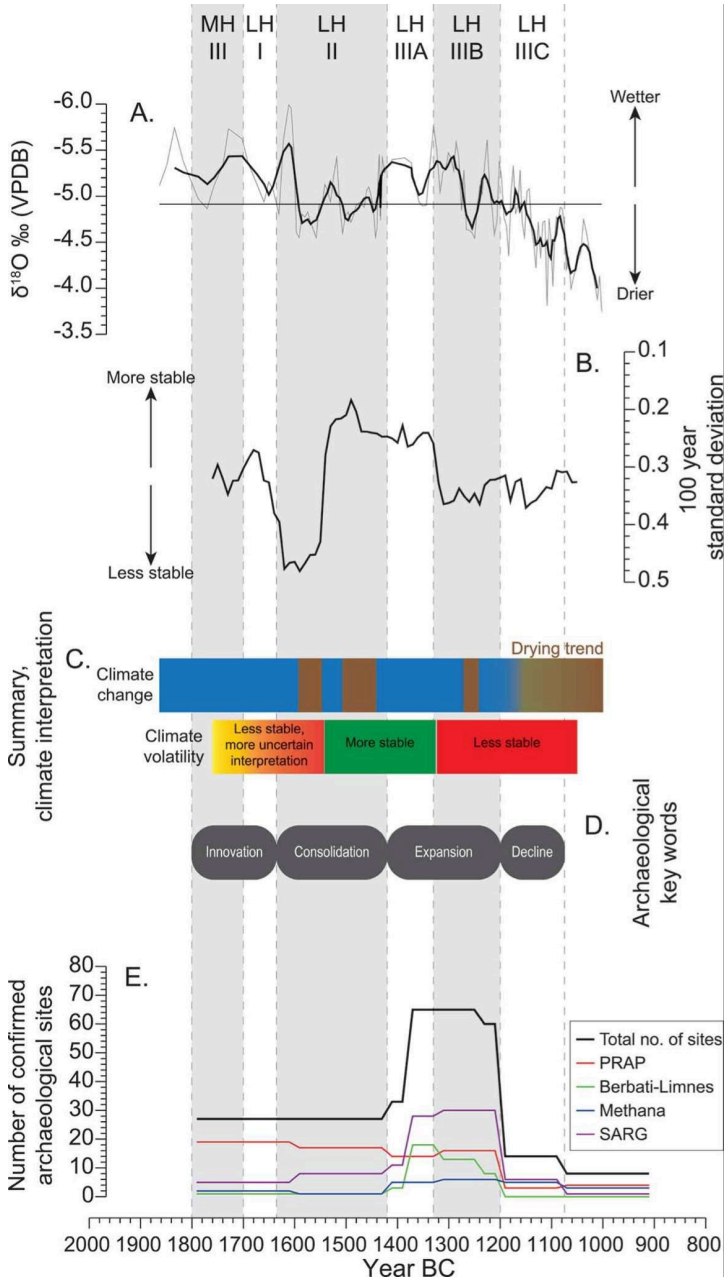


Figure 2.13 (a) Stable oxygen isotope data from Mavri Trypa Cave interpreted to reflect variability in rainfall; (b) Standard deviation in stable oxygen values in 100-year blocks with a new block starting every 10 years; (c) Summary of climate interpretations. Blue and brown bar shows wetter (blue) and drier (brown) climate conditions. Green and red bars show more stable (green) and less stable (red) climate conditions. Yellow to orange segments indicate periods of less stable conditions, but the interpretation is less secure ; (d) Summary of the archaeological interpretations made in the source paper, presented as keywords. (Weiberg & Finne, 2018, fig. 1)

the Greek strawberry tree (*Arbutus andrachne*), tree heath (*Erica arborea*), pine (*Pinus halepensis*), asphodel (*Asphodelus albus*), and grasses. The landscape was parched but heavily wooded and unburdened by large populations of grazing animals. Given that the PCA sits predominantly within the Quercion ilicis growth zone, it is not surprising that there is a paucity of olive (*Olea europaea*) pollen and an absence of carob (*Ceratonia siliqua*), which would have likely been much more prevalent south of the bay.

When the drought concludes at the beginning of MH II, ca. 1850 BCE, the trends of the previous century are inverted. By this time the once dominant stands of deciduous oak plummet by over 50% with only a partial recovery in the subsequent 150 years. Populations of evergreen oaks, such as the kermes oak and holm oak, likewise recede or die back by 50%. Until the very end of this period, sums of pistacia and olive pollen are negligible. Pine populations, on the other hand, boom, increasing by over 50% from their ca 1900 BCE levels, as does the tree heath (+200%). Grasses and chenopods similarly proliferate, steadily climbing in numbers from 1900 BCE - 1700 BCE, until they peak at +250% and +100%, respectively. Asphodel reappears and remains consistently present throughout this period, as does Triticum wheat and other cerealia (other varieties of wheat, barley, and similar wild grasses). The presence of *Tricitcum* wheat and other cerealia is particularly noteworthy, since these taxa are self-pollinators and distribute their pollen in such a restricted radius that their quantities in the MH

samples signals a much more substantial presence than their absolute values in the core would suggest.[192]

The Middle Helladic II - III became a fundamentally different landscape than that of the MH I. Pine, tree heath, and open grasslands replaced the mixed oak forests and woody maquis. The disturbed ground of the cereal farmers and shepherds encouraged the proliferation of asphodels and chenopods in tandem. The oak outcome is particularly interesting here, since climatic changes do not appear to have catalyzed the sudden drop of oak pollen in the fossil record. Moreover, oak species are represented in the fossil pollen record proportional to their living coverage of the pollen catchment area, meaning their pollen distribution corresponds to their actual distribution in the landscape.[193] The abundance and then sudden drop of oak pollen (both evergreen and deciduous) must therefore be a faithful representation of their population trajectory. This episode of depleted oak stocks will be termed **DE 2**.

2.3.2a *Scenario 1: Clearing due to selective exploitation*

The pine/oak ratio here would suggest that the pine, like the grasses and cereals, likewise replaced the oak. It is not uncommon for these trees, which are faster growing, to be more prone to success in environments that are subject to stresses attributed to timber exploitation. Slower growing trees, such as oak and other hardwoods, will often not fully recover when species replacement compounds the culling from timber exploitation. If the region is being cross-utilized for grazing, thick evergreen shrubs and bushes (maquis) overcome the tree populations, because grazing animals consume young tree shoots and preclude the replacement of dead and/or felled trees.[194]

The second tier replacement theory accords with several features of the pollen record. There is a sudden abundance of pine *and* the growth of maquis species. The tree heath, for example, proliferated at the moment **DE 2** occurred. Likewise, while it is impossible to disentangle evergreen oak trees (belonging to the mixed oak forest community) and evergreen oak shrubs (belonging to the maquis community) in the pollen record, the evergreen oak pollen drops and plateaus, signaling, perhaps, the selective exploitation of the trees and de facto preservation of the shrubs.

Scenario 1 is, however, at odds with the other features of the evidence. Considering the increased farming activities in the vicinity of the lagoon and the explosive growth of grasslands, it is reasonable to assume that oak and maquis were cleared by human agents in an effort to modify their environment to make it more conducive to agriculture. Were this the case, there would be little tolerance for a sudden surge in new pine stands. Moreover, throughout this period the area covered by grasses consistently expands, while pine populations remain, at least until the very end of the period, relatively stable. This suggests an anomaly in which grasslands increase in area within the confined catchment zone without encroaching on the pine forest.

[192] Zangger et al., 1997, p. 592.
[193] Zangger et al., 1997, p. 580.
[194] Zangger et al., 1997 p. 579; Bottema, 1974, p.59.

2.3.2b *Scenario 2: Clearing for agriculture*

The question of vegetation cover in proximity to the lagoon is key to understanding this transformation. Cereals, such as triticum wheat and barley, are extremely underrepresented in the fossil record, given that they self-pollinate.[195] The presence of such taxa, especially the Triticum wheat pollen, suggests that there would have been a profusion of cereal growth directly surrounding the lagoon, where their pollen unexpectedly dropped. Conversely, pine pollen distribution is disproportionately prolific, as it can travel much greater distances than pollen belonging to other plant taxa. As a result, the fossil record is composed of pine pollen originating from trees far beyond the spatial range of its other contributors. Considering the subtleties of the abovementioned pollen diffusion, it can be credibly suggested that the PCA[196] was cleared of a substantial proportion of the mixed oak forests and possibly commingled woody shrubs (kermes oak, holm oak, among others). In their stead grew wild grasses, chenopods, asphodels, and cereals. Upon the removal of these oak stands, the distance across which pollen can be transported in the air expands. In other words, without dense clusters of trees, pollen can travel to the lagoon from pine forests much farther away.

The maquis cover would have been, however, just as intolerable to these early farmers as the trees. It is unlikely that this plant community would have been allowed to develop in fields under active cultivation. It must also be acknowledged that a mixed or evergreen forest transitions into a maquis community upon its degradation. The traces of this syntaxa paired with a deforestation event is a correspondence that ought not be elided. Were the forests wholly replaced by agricultural fields, the marks of tiered degradation would not be visible.

2.3.2c *Discussion*

The most probable scenario, which accords with all of the variables, is a combination of both explanations. In the Middle Helladic, populations in Messenia were growing, and the area surrounding the later Mycenaean palace, within the pollen catchment area, doubled its population.[197] According to the UMME survey, there are 58 confirmed MH settlement sites in Messenia, with an additional 49 *probable* MH settlements. The majority of new MH settlements formed in the western portion of the province, abandoning the EH preference for the eastern Pamisos valley.[198] Middle Helladic settlers appear to have preferred inland sites, occupying the coastal region in only 15% of confirmed MH settlements, staying principally in the northern sector of what would later become the Hither province (down from 31% in the EH).[199] These communities tended to be larger than those belonging to the

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[195] Zangger et al., 1997.

[196] "From the Palaeonavarino ridge in the west to hills around Yialova in the east and from Englianos in the north to the Sphakteria ridge in the south" (Zangger et al., 1997, p. 581).

[197] McDonald & Hope Simpson, 1972.

[198] The drought likely made the marshy Pamisos valley arable, but only temporarily. When precipitation levels returned to a normal range, between 1900 BCE and 1850 BCE, the Pamisos would have become too swampy to cultivate crops, but could have easily served as animal pasturage.

[199] McDonald & Hope Simpson, 1972, p. 134.

EH, roughly estimated to have sustained 100 people, or 20 families, compared to the average EH population estimate of 75. Taking into account these larger groups and the proliferation of individual sites, population estimates for Messenia at this time hover around 6,000.[200] While this estimate is very rough, what is salient here is that the inhabitants of MH Messenia appear to have tripled since the Early Helladic, thus adding extra pressure on the landscape.

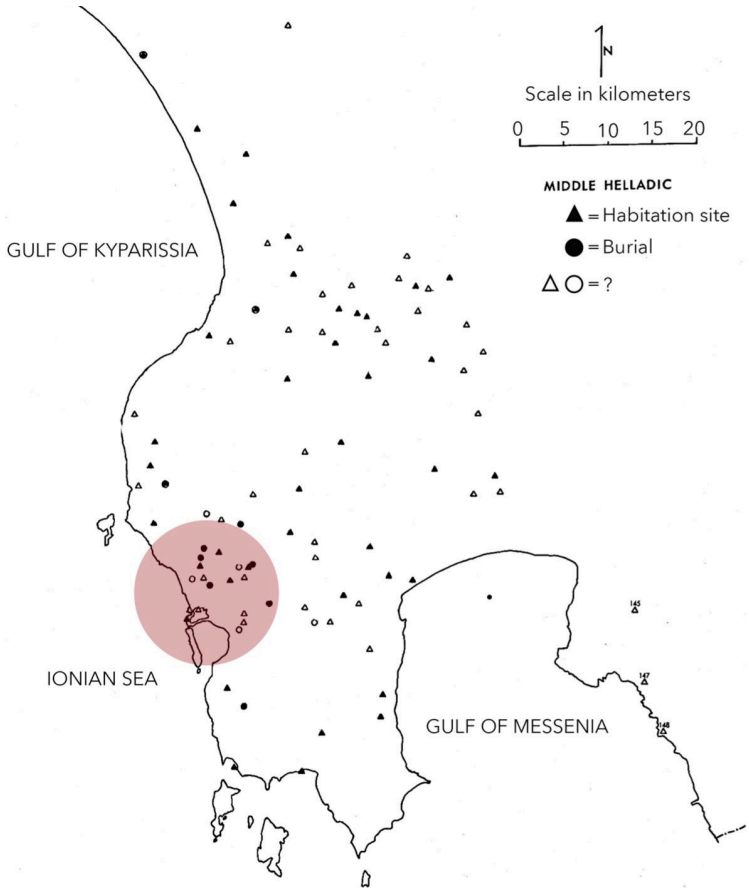


Figure 2.14 Middle Helladic settlement and burial distribution in Messenia. Circle indicates Pollen Catchment Area (PCA) (adapted from McDonald & Hope Simpson 1972, pocket map 8-13).

One could expect, given the caloric demands on a larger population, an urgency to acquire and/or create tracts of cultivable territory, especially in a locale with a greater settlement concentration. Given the forest clearance, the increasing spread of open grasslands, and the appearance of wheat and cerealia in the pollen record, it is highly probable that at least some of the PCA was actively and purposefully converted into farmland. At this time the Selas River was routed towards the south and emptied into the bay on its north shore, where Osmanaga Lagoon now sits. The river would have easily irrigated fields in its vicinity,[201] and its floodplain would have been flat and tillable. Farming along the river would likewise account for the ever scarce wheat pollen taking up residence in the silty stratum of what later became the lagoon.

Such a conversion significantly impacted the local ecology, but the evidence does not suggest it was all-encompassing. Half of the deciduous and evergreen oak remained intact within the PCA, along with, likely, substantial numbers of pine. DE 2 was a *partial* clearing, however, it is still unclear whether the remaining trees survived simply because they occupied land unattractive to farmers, because the caloric demand of the settlement(s) was met by the partial clearing, or whether they continued to be exploited for timber and fuel. What about the maquis? Under what conditions was it given the opportunity to flourish, and where was it permitted to do so?

[200] McDonald & Hope Simpson, 1972, p. 136.
[201] See Section 2.1.1 for a discussion of the floodplain of the Selas River and Fig. 2.3.

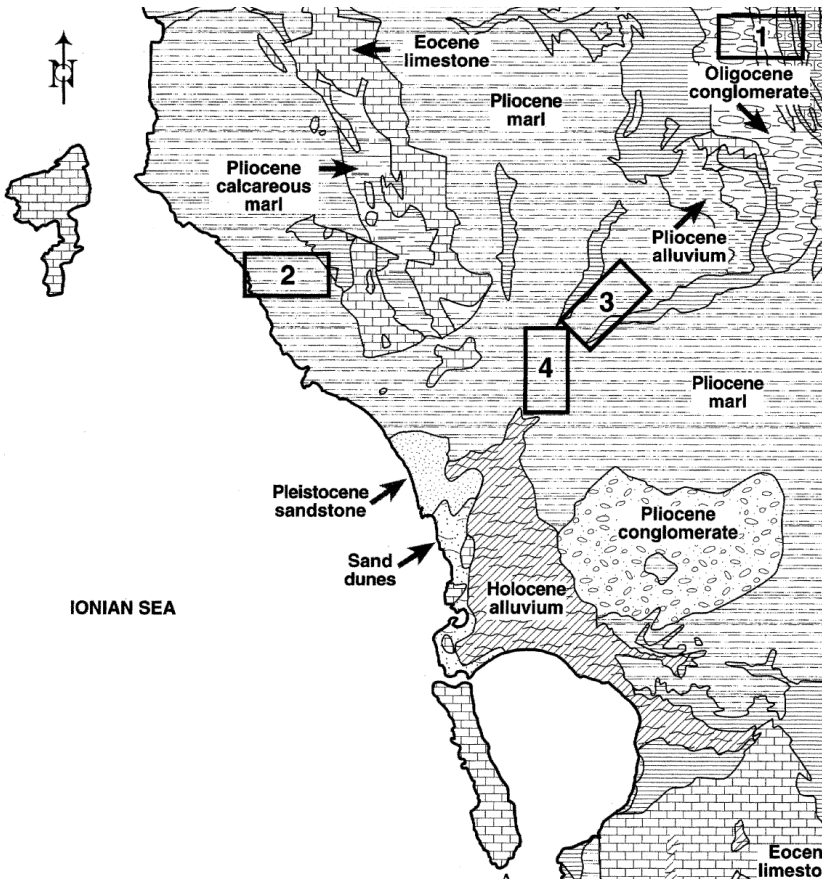


Figure 2.15 Bedrock geology of the PRAP soils study area. 1. Metaxada; 2. Dialiskari; 3. Upper Englianos; 4. Lower Englianos (Zangger et al., 1997, fig. 4).

The floodplain of the original course of the Selas River, extending for 5 miles north of the bay, is composed of Holocene alluvial deposits and would have been continuously inundated with these nutrient rich sediment strata while the river was still running this particular course.[202] A modern analog for the composition of the soil is situated just north in the floodplain of the upper Selas River, in Lower Englianos. This area was chosen for soil analysis in the PRAP Survey in the early 1990s and revealed deep,[203] unstratified fluvial sediment that is the product of the near constant flow of the river.[204] Despite the catastrophic soil degradation elsewhere in the surveyed area,[205] where degenerative farming practices have denuded it and led to considerable erosion, the floodplain of the Selas in the Lower Englianos remains highly productive. It can be surmised, therefore, that while the river flowed south into the lower floodplain and emptied into the bay, this area would have likewise had high agricultural potential. Not only was the soil deep and rich, but it would have sustained shorter crop cycles without depleting essential nutrients. Intensified cultivation, therefore, could have been achieved in the Holocene floodplain with little added expense.

Beyond the floodplain intensive, short fallow cultivation would have been more costly, either requiring longer fallow periods or application of fertilizer. The Pliocene marl terraces east and north of the floodplain are not disturbed by erosion or fluvial processes and, as a result, have been relatively stable for approximately 100,000 years.[206] Near the coast increased salinity can be surmised, while acidity increases as you move inland. Agricultural potential here, however, is moderate, requiring irrigation and fertilization procedures. A bush or forest fallow cycle could remedy the limitations of

[202] Zangger et al., 1997; Kraft et al., 1980.
[203] 4-5 m depth identified via augur core (Zangger et al., 1997, p. 566).
[204] Zangger et al., 1997, p. 567.
[205] Metaxada/Kalopsana, Upper Englianos, and Dialiskari (Zangger et al., 1997).
[206] Zangger et al., 1997, p. 561.

these static landforms, as could the application of manure and domestic debris between crop cycles. A bush fallow cycle brings down the total required land area to sustain one family[207] from 12 to 6.5 hectares, nearly half the requisite forest fallow/shifting cultivation land estimate, while an intensive strategy with short or no fallow periods reduces scale even further, 0.86 hectare.[208] If we were to deploy the very rough population estimates posited by McDonald and Simpson (1972), the PCA, composed of 5 confirmed and 6 probable MH settlement sites, each occupied by roughly 100 people (20 families), then the ~6 sq. miles (1,554 hectares) of arable land[209] in the catchment would sustain the population under various farming conditions:

	100 families (*min*)	220 families (*max*)
Intensive (short/no fallow):	86 ha	189.2 ha
Extensive A : (bush fallow)	650 ha	1,430 ha
Extensive B : (forest fallow/shifting cultivation)	1,200 ha	2,640 ha

Table 2.1 Estimated land requirement for minimum and maximum population in the region according to agricultural strategy.

I posit that the MH farmers utilized a composite cultivation program, in which the land that could have been cultivated intensively with little added cost (time, labor, maintenance of animals) was indeed brought under sequential crop cycles with short grass fallow periods, or none at all, while the poorer soils surrounding this area were allocated fewer man-days and resources under a bush fallow scheme. In the eastern hills at the periphery of these coastal plains, harder to reach locales may have also been exploited, however given their relative distance/inaccessibility, crop cycles may have been substantially less frequent.

The deliberate replacement of the mixed forests with grass, cereals, and maquis is harmonious with a composite cultivation system of land tenure. The Holocene floodplain nourished and irrigated by the Selas River would have easily accommodated the caloric demands of a growing community, and its intensive exploitation would have remained relatively economic. Without much added effort, settlers within the PCA could have grown wheat, which requires more water, and other cereals in succession, while maintaining the cultivars in weaker soils and plots farther afield less intensively. In

[207] According to McDonald and Hope Simpson (1972), a family is estimated to be 5 people.

[208] Estimates based on farming communities in Mexico (Netting, 1986, p 70).

[209] This estimate is based on a rough measurement of the total land area in the PCA, ~20 sq. mi, subtracted from which a conservative estimate of the percentage of this area likely too steep to sustain agricultural practice without terracing, 15%. Based on the pollen record, deciduous oak forests cover ~30% of the PCA and ~25% pine cover, which would have likely been utilized for grazing. This is further subtracted from the available arable land quotient.

these places the maquis and pine quickly filled the spaces once occupied by oaks during periods of bush fallow, while animals were granted pasturage there as the field rested, fertilized by dung, and the soil recovered. As they were cleared once again for sowing and cultivation, the wood of the bush and pine may have been used for fuel, and/or it was slashed and burned. Such clearing would be imperceptible in the pollen record without finer temporal resolution, but what can be observed evinces more general trends.

2.3.3 *The Mycenaean Period ca. 1700-1200 BCE*

The climate remained relatively consistent at the beginning of the Mycenaean period, as $\delta^{18}O$ levels hover around -5.5 between 1700 and 1600 BCE, bestowing on the farmers both rainfall and (relative) climatic stability. The subsequent century, however, sees disruptive climatic patterns. While these disruptive patterns are not on the scale of the 4.2 Event, overall stability nevertheless plummets (see section B in Figure 2.13 on p. 66), and between ca. 1600 and 1400 BCE mean moisture levels twice drop below the aridity threshold (ca. -5.0 $\delta^{18}O$), causing two approximately 50 year dry spells. Climate stability and rainfall returned once again to southern Greece in 1400 BCE, and the western Messenians enjoyed atmospheric conditions conducive to dry crop (non-irrigated) farming for another 100 years. This respite was not long lived, however, and southern Greece slipped once again into a protracted drought. Moisture levels starting in ca. 1300 BCE waned with every passing year, and the peaks that constitute the typical $\delta^{18}O$ sequence descend ever lower, never fully recovering from the prior valley. Moisture levels trend lower still between 1300 and 1000 BCE, at which point, when $\delta^{18}O$ reaches drought levels (-4.0), the stalagmite again ceases to grow. As a result, during the final century of Pylian control over Messenia, prior to the destruction and collapse of the palace ca. 1200 BCE, the population was victim to ever more arid conditions.

The favorable climatic circumstances between 1700 and 1600 BCE was coupled with consistency in the vegetation cover. The proportions of deciduous oak, evergreen oak, maquis, grasses, pistacia, olive, and cereals remained surprisingly stable across time. The transformation of the Deforestation Event 2 (DE 2) were not reversed, nor did they catalyze precipitous trajectories. Deciduous oak cover maintained between 25-30%, Evergreen oak covered ca. 7% of the land in the PCA, Triticum wheat and other cerealia stayed present in the pollen record, grasses and chenopods sustained their peak–ruderals that index disturbed ground–and maquis indicator species (tree heath, pistacia, evergreen oak, judas tree, rock rose) maintained their sudden surge following DE 2. Pine, however, deviates dramatically from previous patterns. While the plant communities in the catchment area carry on relatively uniformly, Pine pollen levels in the fossil record begin to fall ca. 1700 BCE and decline steadily until ca. 1400 BCE, at which point they are absent altogether. This turn is quite stunning considering the endurance of the other distributions. By the LH IIIA period, pine stands are wholly and permanently deforested.

Following this deforestation, and possibly as a direct result of it, marked shifts occur in the local ecology. Olive coverage, which had been increasing slowly since 1700 BCE, proliferated suddenly after 1550 BCE, dominating 10% of the landscape. Simultaneously, rock rose (*cistus*), asphodel (*Asphodelus alba*), chenopods, and ribwort plantain (*Plantago lanceolata*) climb in numbers, signaling,

in combination with the expansion of grasslands, extended phrygana and pseudo-steppe environments.[210] In the waning days of the pine, ca. 1550 BCE, deciduous oak has a curious trajectory. According to the fossil pollen record, it took a sudden hit, falling by 60% in the fossil record only to recover fully within the following 50 years (in the subsequent sample). This is, however, a distortion resulting from an anomalous sample. At 300 cmbd the sum of all the pollen grains present in this one particular sample jumps from ca. 350 within the 1cm x 1cm sample to ca. 700. The 100% increase in total pollen appears to have resulted from a sudden influx of chenopod pollen, since these values also suddenly spike at 300 cmdb. In the PRAP II volume the data is presented as a proportion distribution; each taxon accounts for a *percentage* of the pollen sum, rather than a true count. As a result of the chenopod inundation at this level, proportionally oak, pistacia, and tree heath represent less of the sample, yet their absolute values remain consistent with the previous and subsequent samples. Concealed behind the guise of decline and recovery, therefore, there is uniformity and durability in deciduous oak, pistacia, and tree heath populations.

This is a curious turn of events, and it appears that 1550 BCE marks the moment of change. In a use practice beginning in 1700 BCE, the pine populations were eliminated permanently in the catchment area, subsequently degrading into phrygana and pseudo-steppe. The mixed farming system of the Middle Helladic persists, as maquis species and cereal cultivars seem to maintain their allotted acreage. After 1400 the phrygana plants, grasses, and chenopods declined at the same moment when, beyond the bounds of these MH fields, olive cultivation enterprises gained favor. Meanwhile, despite the pinewood scarcity, oak forests are sustained. For the entirety of the Mycenaean period[211] excessive exploitation of pine is paired with restricted or sustainable use of deciduous oak, and, most importantly, the complete deforestation of pine *did not* spur users to cultivate oak timber using the same unsustainable practices that they employed with pine. Dissimilar population recovery conditions required for these two taxa underline the differences in exploitation practices. As has been mentioned above, deciduous oak trees grow slowly and are intolerant of grazing activity, while pine grows quickly and can endure animal encroachment much more successfully. In other words, oak forests are sensitive to human interference, and overuse would likely leave a pronounced, more enduring mark on their range and composition. The pine outcome was decisively not shared with the oak forests, indicating that exploitation strategies likewise differed. This final deforestation event (**DE 3**), was species specific.

2.3.3a *Scenario 1: Clearing for agriculture*

Just like the demographic growth that prompted DE 2, the Mycenaean period is characterized by increased size and quantity of settlements. Settlements identified from the Late Helladic period by

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[210] Zangger et al., 1997, p. 589.

[211] The pollen data for the Mycenaean period begins in 1700 BCE and ends in 1350 BCE. The terminus in the available data does not align with the destruction of the palace and the Mycenaean state in LH IIIB, but is the moment when deposition patterns in the lagoon change such that 300 years of pollen occupy a mere 10 cm of the core, which, prior to 1350 BCE, would have occupied 60 cm. This deposition transformation may be the result of growing aridity, but most likely marks the moment at which the course of the Selas River was artificially rerouted. This event would have restricted the flow of water to the area where the lagoon now exists, thus reducing the sediment and pollen deposition.

the UMME and PRAP surveys amount to 168 certain habitation sites and 27 probable habitation sites, however, the true number may be closer to 250. MH settlements more often than not carry into the LH with continuous habitation, and the area around the Bay of Navarino and up into the Upper Englianos, the pollen catchment area (PCA), continues to have a greater population density than elsewhere in Messenia. The settlements themselves have also grown. Based on the average size of the 140 sites that could be measured, McDonald and Simpson (1972) posit a 1.6 ha habitation zone, which would have housed roughly 210 individuals. The calculated habitation extent is double that of the MH, which measured 0.8 ha. The conservative aggregate population estimate, which is based only on the currently identified LH habitation sites, is 41,000 people, while the more likely total is closer to 50,000, assuming quite sensibly that many are yet to be discovered.

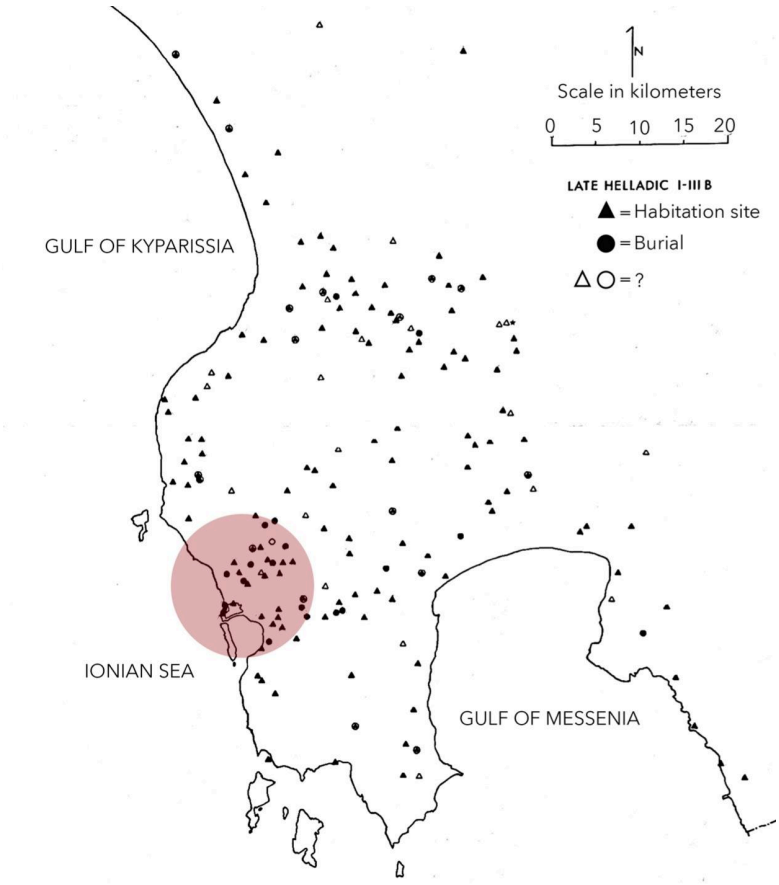


Figure 2.16 Late Helladic settlement and burial distribution in Messenia. Circle indicates Pollen Catchment Area (PCA) (adapted from McDonald & Hope Simpson, 1972, pocket map 8-14).

Within the PCA demographic estimates suggest that at least 3,780 individuals occupied 18 discrete habitation areas, making this a sizable jump from the meager population maximum of 500 in the MH. Caloric maximization would have been imperative with this quantity of occupants, and it would be reasonable to assume that the pine stocks were chiseled away so as to bring forested land under productive cultivation. Mixed cultivation methods would have required roughly 2,200 ha of land to sustain the caloric burden of the inhabitants and quality of the soil, which is beyond the quantity of land available when the pine forests are present (1,550 hectares) and just shy of the 2,850 hectares of arable land available once the pine had been decimated.

The vegetation history, however, tells a different story. When pine began its downward trajectory, plants belonging to phrygana and steppe environments grew in number. This particular pattern reflects forest degradation over time, an evergreen forest transitioning from a climactic syntaxa to a degraded one. Rather than carving the forest up and replacing trees with agriculture, it seems that population loss occurred gradually, and the replacement with low scrub taxa was unplanned and incidental. And just like the inverse relationship between the pine trees and the shrubs of the phrygana

and grassy pseudo-steppe, where an open scrubby landscape replaces a forested one, the phrygana/pseudo-steppe and olive also present inverted trajectories. After DE 3, in the neighborhood of 1500 BCE, asphodel, chenopods, grasses, and ribwort plantain pollen sums fall in the fossil record by as much as 70%, and olive pollen increases by 300%. Once again, vegetation replacement within a confined area takes place. The pine forest is replaced with scattered grass and low scrub, which is subsequently replaced by olive orchards. The inverse correspondence between these plant communities demonstrates that each episode, the consecutive rise and fall of pine, phrygana and pseudo-steppe, and olive, took place on the same land and were in fact *replacement* events. Moreover, this particular sequence bolsters the idea that DE 3 was not motivated by agricultural land acquisition but rather made possible the later installation of orchards.

2.3.3b *Scenario 2: Deforestation due to selective exploitation*

Based on the pollen record, the cost of growing demand for construction materials, fuel, and furnishings was absorbed by by the pine populations, and beginning in 1700 BCE the resource was exploited unsustainably, by which strategy the felled trees were not replaced quickly or sufficiently enough to restock the forest. Rules that regulated access and usage were not issued and/or enforced, and despite the resilience of these populations in the context of human encroachment, the pine was completely and permanently removed from the landscape over the course of 200 years.

The exploitation of wood sources is a predictable human endeavor, and even its *over*exploitation is a logical outcome of population growth. What is curious, however, is the unevenness of this pressure across species. Demand for wood does not alone account for the use pattern evident in the data. Despite growing fuel and timber exigencies, deciduous oak did not have a corresponding diminishment. Even in the face of scarcity, when the pine stocks were wholly depleted, oak exploitation was subject to different practices. Wood acquisition modalities were not transferable; pine felling had a system of rules, either formal or informal, and practices that were not applied to oak felling, and vice versa. This disparity suggests heterogeneous assumptions of value and *use*-value,[212] with the oaks bearing some intrinsic, perhaps even *abstract,* value in their living condition, and pines bearing value only in their use potential and their transformation into a resource or commodity.

2.3.3c *Discussion*

The land once peppered with pines seems to have remained the domain of the pastoralist during the 200 years of DE 3, and animals grazing on the exposed and degraded understory suppressed the forest's recovery. Plots of newly opened forest floor may have supplied communities with agricultural produce, but for the most part the event appears to be patchy and irregular enough that phrygana and pseudo-steppe prevailed as it was degraded. Based on the subsistence requirements of the population, which exceeded the productive output of coastal land under a bush fallow cultivation system, it is likely that topographical constraints precluded the pine forest from being cultivable.

[212] See Ingold, 1992; Ingold, 1993; and Gibson, 1979 for more on the distinction between valuation systems.

Higher altitudes and steep, rocky slopes would have made this land, even once cleared, impossible to till and irrigate, thus confining its use-value to pasturage. Distance may have also been a factor. As was mentioned above, pine pollen is prone to long distance travel, and those pollen producers may have belonged to a landscape too far from the settlement center to apply regular maintenance

In light of these restrictions, intensifying agricultural practice on the available land, rather than extending agricultural territories, would have been a necessity. Fallow periods would have necessarily been shortened in plots beyond the rich floodplain, a process that relies on costly fertilization routines. We can assume, therefore, that domestic animal populations would have grown in tandem with human populations, since maintaining the fertility of the soil so as to feed the ~3,700 individuals in the PCA demands the frequent collection and application of manure. As such, retaining the dwindling, then absent, pine forest territory for pasturage serves this end. It is not until the pine trees are completely deforested does the olive cultivation program begin. Like pine, olive trees can grow on steeper, un-terraced slopes and are well adapted to mediterranean climatic conditions with long, dry summers and variable rainfall in the winter.

All the while, as we see pine wood supply dry up and vanish between 1700 and 1500 BCE and a new agricultural program of olive cultivation develop from 1500 to 1350 BCE, the oak is unvarying. The use-value of oak will be discussed further in Chapter 4, however it can be assumed that the living oak stands *were* transformed into timber resources, either in domestic and monumental architecture, or ship construction, however the exploitation practices are unique and distinct from those performed on the pine, because they were sustainable. Rules, either formal or informal, concerning proper use and acquisition of oak wood allowed this species to maintain stability throughout the Mycenaean period. These practises may have included coppicing, restricted felling,[213] or limited access. Wood fuel acquisition may have been exclusive to deadwood. Whatever the case, the disparity between oak and pine trajectories between 1700 and 1350 BCE is significant.

2.4 *Summary*

It is at the intersection between population and geography, climate and vegetation, that the stories of communities, both human and plant, are recorded in the depths of Greek prehistory. The outcomes of changing climatic conditions, adaptations to growing populations, and the silhouettes of systems of values are folded into the landscape, a palimpsest imprinted by millennia of human and non-human lifeways. In Messenia these traces are faint, as its coastal plains, hills, and mountains have submitted to the unyielding grip of modern mechanized farming programs. This subjugation in the modern ontological paradigm, where an inert environment and agentive human ambitions exist in discrete and hierarchical worlds, object and subject, is neither axiomatic nor inevitable. Rather, the myriad tasks, transformations, perceptions, and acts of meaning-making, which constitute the project of dwelling in western Messenia, exist in a dynamic dialectic with the landscape. The nutrients in the

[213] Restrictions may be temporal, or they may have limited the numbers of trees per family or community that could be cut down, or they may have reserved access to the resource for a select stratum of society or specialized user.

soil and distribution of rainfall and river courses, the feeling of safety and the comfort of custom and tradition in one's choice of habitation, and the pathways of daily life with its familiar landmarks and habits are experiences of human life shaped by the landscape. In turn, the rhythms of dwelling shape the landscape.[214]

During the "4.2 Event," the western Messenian landscape was hardly hospitable. The protracted drought lowered the carrying capacity of the region and atomized its inhabitant. Few, scattered human settlements freckled the coastlines, mostly clustering in the Pamisos valley. The low overall population and population densities would have neither sustained nor justified costly terracing or irrigation projects. As a result, the impact of their dwelling folded lightly into the form of the landscape. In the Middle Helladic and beyond, a community places its settlement inland and uphill so as to maintain its safety. They build and rebuild their homes in the same location continuously for centuries, as rooms, hearths, and memories are stacked ever higher. Humans and animals set about their daily tasks, disturbing the earth and inviting chenopods, asphodel, and other segetals to grow in their footsteps. Nearby they cull the evergreen and deciduous oak trees, opening up the fields for cultivation of cereals and other cultivars. The rich soils of the Selas River floodplain are passively replenished of their nutrients, as the river flooded seasonally and deposited thick blankets of sediment. Further afield the rhythm of cultivation is slower. The plots are opened and then rested, and the maquis and forests from which they were claimed reabsorb them, tending to them in perfect partnership with the human inhabitants, like a duet. Bush, forest, and settlement execute the tasks of their life cycle with dynamic reciprocity. In the uplands where steep slopes, rocky cliffs, and dense forests discourage the farmer, grazing animals are shepherded during the non-winter months to feed on the undergrowth.

The ecological equilibrium in the Middle Helladic fostered population growth and social complexity in the Mycenaean Period, which in turn prompted a revised adaptive coping strategy. Based on the settlement distribution in the Late Helladic, new communities in the catchment areas cropped up, and their overall size increased by 20%.[215] Moreover, the form of the mortuary spaces and their spatial organization transitions between the MH and LH, moving from public tumuli bearing few grave gifts to tholoi with restricted access and a wealth of grave gifts.[216] The social composition of these settlements and the greater Pylian Kingdom will be further discussed in the next chapter, however

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[214] This interpretive framework has been modeled after Tim Ingold's 1993 article *The Temporality of the Landscape*. Here, he challenges the dichotomy between "nature" and "culture" and develops a more dynamic, animated view of the interface between human beings and their natural environments, wherein the tasks and actions of daily life both shape and are shaped by the landscape.

[215] The *maximum* populations based on the settlement survey data in McDonald & Hope Simpson (1972) is indeed a moderate estimate. A complete list of the MH and LH settlement sites has certainly not been compiled, due to inevitable preservation issues and modern obstructions. As such, the *max* estimate based on survey data actually represents a *median* estimate, which is the number that has been employed in the ecological reconstructions of this chapter.

[216] See the following sample of the prolific Messenian mortuary publications for more information about burial practice and the evidence of social stratification and state formation in the mortuary space: Boyd, 2002; Cavanagh, & Mee, 1998; Davis et al., 1997; Galanakis, 2017; Hood, 1960; Lewartowski, 1995; McDonald & Hope Simpson, 1972; Mee & Cavanagh, 1984. A further exploration of the western Messenia's political context in the Middle and Late Helladic will be presented in Chapter 4.

within the context of the ecological modeling, it is suggestive that the evidence of stratified wealth and status is paired synchronously with changing engagements with the local vegetation and landscape. The pine forests that nourished the shepherd's flocks with their shrubby understory and fed the fires of those making and dwelling in its vicinity absorbed the impact of changing demands and practices–it embodied the social transition of the inhabitants, just as the tholoi did. Over the course of 200 years the economic potential of a felled pine superseded its living value, and by 1500 BCE the forest's shady corridors and pockets of bright pasture had been wholly replaced by low scrub and flowering and herbaceous plants that follow at the heels of the shepherd, flock, and woodcutter. Subsequently, the formal qualities of the folded, chiseled, and jutting Messenian landscape influenced the pathways and use-ways of the land thus cleared, privileging commercial produce (olive oil) over subsistence.[217] Despite changing timber and fuel demands, the oak was differentiated, its use-value never inviting its subjugation and ultimate destruction. On the contrary, the exploitation interface was mediated by some cultural attitudes and conventions of appropriate use.

The social implications of the ecological outcomes evidenced here come into higher relief when paired with the behaviors and demands that shaped human-ecological interactions. Given the landscape transformations of the Middle and Late Helladic Periods, it is now important to understand the pressures that were exerted on the Messenian forests during the period of state formation.

[217] See Chapter 3 for a more thorough discussion of the commercial potential of and palatial interest in olive oil production.

3. WOODLAND MANAGEMENT AND ITS RESOURCE DEMANDS

There is a reflex in state policy, both now and in the past, to lock into one of two conflicting views of forest management, or even the *raison d'etre* of the forest more generally: the *moral forest*, a vestige of our primordial past, unblemished by the appetites of humankind, and the *crop forest*, an asset that serves and supplies human enterprises.[218] These views of this resource/ecosystem have roots and shoots; they are both informed by our experiences, values, and beliefs, and accordingly inform public opinion, policy and practice. It is, of course, exceptionally difficult to surmise which vision of the forest asserted itself in Bronze Age Messenia, whether it changed over time, and whether overlapping visions created discord, as it does in modern U.S. forestry. Yet to model the beliefs, conditions, and outcomes of observable human-forest relationships affords the ability to align the environmental outcomes, revealed in Chapter 2, with schematic pathways of thoughts and decisions. The annihilation of the local pine stock in the Late Bronze Age, expansion of open fields and olive orchards, and the conservation of oak woodlands are the consequences of centuries of choices, mediated by power arrangements, that reflect the beliefs and values of the forest appropriators. Those intangible provinces of choice, where *ethos* and *ethnos* are manifested, can actually be charted in the landscape by using the palaeoecological data (ecological outcomes, supply) and demand calculations, to plot the pathway that traces back to them.

3.1 *Appropriator Values and Visions of the Forest*

The divided forest visions in the U.S. is the result of conflicting values that are informed, essentially, by *scarcity*. The urban dweller commonly values conservation over exploitation because they have a stake in the protected existence of their sanctuary of wilderness, and they fear that logging and development will eradicate places of urban reprieve (both for themselves and for larger ecological communities). Conversely, rural dwellers have a stake both in the economic potential of the forest (logging, saw mills, paper mills, etc.) as well as forest-adjacent lifeways, sense of place, and identity, all of which come under threat when their engagement with the forest becomes subject to exogenous policy and restrictions.[219] As a result, public forests legislation, particularly in the 20th century, attempts to serve every master. For example, the Multiple Use Sustained Yield Act (MUSYA), legislated in 1960, "not only [promises] timber, forage, water, fish, game, and recreational opportunities, many of which conflict with each other, but it is also supposed to regulate public use to preserve wildlife diversity and forest aesthetics."[220] Controversy and gridlock necessarily ensue when the ambitious promises of legislation collide with the operational and financial realities of forest management. The outcomes are thus mixed; some areas are cordoned off and shielded from any interventions (even to the detriment of the landscape; *cf.* forest litter and wildfire vulnerabilities), while others are stripped

[218] The "moral forest" is a term borrowed from Michon et al., 2013, p. 5; the name "crop forest" has been developed here out of a synthesis by the same authors who distinguish the moral forest from a "second forest vision [that] refers to nations' interests and focuses on forest valuation, mainly through wood production (timber, fuelwood)" (Michon et al., 2013, p. 7).
[219] Nie, 2008, pp. 16-17.
[220] Nie, 2008, p. 34.

without reserve. Likewise, landscapes are administratively fragmented and managed variously by the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and the U.S. Fish and Wildlife Service (FWS), as well as real estate/timber corporations and private landowners. The pattern on the landscape mirrors the schismatic modes of thought.

The former vision is from a familiar, urban prospect, as the *morality* of such a landscape is married to the awareness, shame, and distress resulting from resource destruction. Recognition that something must be saved is a reaction to the sense that something good is under threat, or some boundary has been transgressed. In the recent past, this vision prompted the formation of the National Park Service, the U.S. Forest Service, and myriad conservation groups working worldwide. As a direct result, millions of acres have been set aside for "the preservation, from injury or spoilation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition."[221] More recently this orientation has expanded into more general environmental concerns pertaining to the preservation of ecosystems, biodiversity, watersheds, and staving off the devastating effects of climate change.[222] Beyond beauty and recreation, the virtues of the moral forest have evolved into mortal imperatives.

Yet general enthusiasm for and "loose public consensus" in support of protection and conservation efforts run concurrent with the other prevailing attitude,[223] which values forests as market-driven agricultural stock, primarily as a source of fuel wood and timber. This attitude toward trees as crops is mirrored in the federal organization of the Forest Service, an agency of the U.S. Department of Agriculture. At the birth of the U.S. national park and the forest services in the late 19th century and up until today, extraction is the principal interest. The federal and state administered forests in the U.S. are intermixed and regulated through different agencies, and further laced with land given to railroad companies, lumber companies, school trusts, and private landowners in a checkerboard pattern. This inexplicable distribution makes macro scale conservation efforts impossible and incentivizes clearcutting and development. Public (state and federal) forests are likewise profit sources through timber cutting, as is evident from the Timber Wars mentioned in Chapter 1. Other budgetary incentives ensure that maximizing timber extraction is the most successful enterprise. More specifically, the National Forest Revenue Act of 1908 promised 25% of the profits from timber sales derived from public forests went to public infrastructure, namely schools and roads, and the Knutson-Vandenberg Act of 1930 required that national-forest timber purchasers deposit a portion of the cost to a fund that finances the forest service itself and its forest management projects (forest regeneration, wildlife preservation, etc...).[224] Naturally, this encourages high volume extractive practices (clearcutting), concealed by narrow ribbons of aesthetic woods that line the roads and recreational areas, called "beauty strips" (Figure 3.1).[225]

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[221] 45th Congress, \ HOUSE OF REPRESENTATIVES. (Ex. Doc, 2d Session. (i No. 75.) Yellowstone National Park. Letter from the Secretary of the Interior, in regard to the better protection of the National Park from injury. March 6, 1878.
[222] Michon et al., 2013, p. 5.
[223] Klyza & Sousa, 2007.
[224] Nie, 2008, p. 24; Act of June 9, 1930-(Knutson-Vandenberg Act); Popularly Known as the Knutson-Vandenberg Act; Chapter 416 of the 71st Congress; Approved June 9, 1930.
[225] Scott, 2020.

Michon, Nasi, and Belent (2013) direct attention to a third, less observable view of forests that falls neither under the banner of conservationists nor under the influence of the logging industry: the rural forest. These belong to the provinces of the domestic economy, interlaced with fields and pastures in the possession of and managed by farmers.[226] Because the rural forest is not administered by public forestry professionals nor exploited as a timber crop, it sits awkwardly within forest regulatory strategies. Rather than *conservation* or *produce* being the objective, its "existence relies on specific practices and their design incorporates strong livelihood and social dimensions... evolv[ing] from long-standing and complex domestication processes targeting trees, ecosystems, and landscapes."[227] As a result, the relationship between farmers and forest managers tends to be that of a bad marriage. The flattened definition of "forest" makes the *rural* forest subject to "normative and prescriptive frameworks" that favor state intervention and policy over traditional ecological knowledge and the interests of the farmer or community.[228] In fact, in Indonesia any trees growing on the property of a farmer that are *not* considered "agricultural trees" (such as fruit orchards) belong by default to the state and cannot be managed by the property owner.[229] Widespread policy failures in combination with market driven agricultural maximization measures have forced these spaces and the interests of their stewards into compromised positions. Yet this view of the forest, which fosters mutual adaptation between human and plant communities, biodiversity, income generation, and sustainable stewardship, is a natural extension of agricultural activities and has many ecological benefits. Farmers may select for (and prune) the perfect shade tree for their barley crops, plant a diverse stand that has resilience and regenerative capacity, integrate wild and domesticated trees that can survive abandonment, create game hunting and foraging spaces (for both people and livestock; *cf.* truffles), coppice and pollard trees for sustainable fuel collection, and integrate trees into landscape infrastructure in order to mitigate erosion and maximize water retention. All of such efforts intersect with deeply traditional lifeways and shared-use practices.



Figure 3.1 Photograph of "beauty strips" in an area clear cut by a logging company in the Pacific Northwest.

[226] Michon et al., 2013, p. 3.
[227] Ibid.
[228] Michon et al., 2013, p. 4.
[229] The authors point out that the conflict over sandalwood trees, whose presence and integrity are tightly regulated by the government, has resulted in so much harassment that farmers habitually choose to simply uproot the trees growing on their property in an effort to avoid it.

The *community forest enterprises* (CFEs) in Mexico provide an interesting foil to the gridlock and mismanagement in the United States. As a result of the Mexican Revolution, over generations 56.8 million hectares of forested land (40.1% of Mexican territory) have been placed in the charge of *ejidos* and local indigenous communities as community-managed common-property. While in earlier periods the Mexican government retained control over the management of the forests and allowed logging by private companies to continue, by the mid-1970s the system was reformed such that the communities alone would manage both the timber and non-timber forest resources. Consequently, the Mexican CFEs have mastered financial and ecological sustainability, funding local infrastructure through the sale of wood and finished wood objects while in many places also expanding the forest canopy, increasing biodiversity, and protecting endangered species.[230] This enterprise is reminiscent of the rural forest, wherein the local appropriators (landowners or community members) are precisely those who make decisions *with mutually beneficial outcomes* about exploitation, domestication, and protection.

In the abstract and very broadly speaking, speculation about prehistoric views of the forest thus may be extrapolated by modeling the intersection between a) beliefs/values and b) the degree to which the resource appropriators have influence over prescriptive use and management strategies. All of these conceptual threads are woven into the landscape; thoughts and beliefs inform varied forest visions, and decision-making power determines how those thoughts and beliefs inflect appropriation practices. A crop forest vision may take the unsustainability pathway, being paired with a sense of wealth or "way of life" scarcity that motivates users to discount future returns (i.e. demands on surplus, steady wage requirements, demand for manufactured goods that claim large volumes of fuel or timber wood, etc...) or a sense of abundance. This may lead users to clear-cut or over-extract to such a degree that the forest suffers sustainability and species loss. Biodiversity also suffers as fast-growing replacement trees outcompete other tree species; replacement trees of the same age and species, standing tightly together, crowd the canopy and darken the forest floor, compromising the herbaceous understory.[231] Like the shrinking patches of sunlight piercing the treetops, the larger ecosystems of fauna, fungi, and microbes narrow.

The crop forest vision may also take a sustainability pathway, particularly when the perception of resource scarcity is unobstructed by crises or market pressures. In the case of the Mexican CFEs, the authority to extract timber shifting away from licensing agreements between private logging companies and the Mexican government and towards the local communities participating in wood/wood products markets in the 1970s abruptly changed the local ecology. Private logging companies and the federal government, perhaps afforded with a sense of abundance derived from their ability to access many/all Mexican forest environments, appropriated wood in a less sustainable manner. The CFEs, on the other hand, entered into international markets profitably while simultaneously recovering canopy cover and biodiversity. That the area under each community's control is finite makes the resource, in a sense, scarce. Once depleted they cannot easily move on to a new locale and replicate over-exploitative practices. Additionally, based on their management autonomy, the sense of resource scarcity and interests in long-term profit horizons of the CFEs manifest in procurement policies and practices.

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[230] Bray et al., 2003.

[231] In a comparative study between primary forests and 50-87 year old secondary forests in Appalachia, investigators discovered that total understory cover and species richness never recovered from clearcutting: Duffy & Meier, 1992.

Ecologically, the moral forest may not look dissimilar to the above example. Diverse species, ages and sizes, and elevations of vegetation cover are diagnostic features of a sustainably managed forest, along with some diachronic stability in the populations of most taxa, greater water retention, and little to no erosion. The pathways of a sustainable crop forest and a moral forest may look identical, however subtle differences in practices individuate these landscapes. In particular, given the necessity of forest resources (evident even now when alternative fuel sources are preferred), the unspoiled tracts are *necessarily* circumscribed. It would be difficult to set aside every tree in every forest for the sake of conservation when meals need to be cooked on stoves in houses that need to be built. The existence of the moral forest, therefore, is fundamentally dependent on other types of forests that serve the needs of people.[232] Such bounded sanctuaries may have discrete behavioral restrictions that prohibit the collection of firewood, forest litter, and/or produce (edible nuts, bark, fruit, leaves, etc.) by human beings *and* grazing animals, as well as the appropriation of open spaces for farmland. Sequestered grazing and farming may thus be further diagnostic features. In the Greek historical period, protections for sacred spaces were codified, forbidding the chopping of trees or branches and even the collection of deadwood, and rewarding informants who report harm done by other visitors. In some cases every leaf that fell was itself sacred and must stay where it fell.[233] Farming and, most importantly, grazing might thus threaten the integrity of the protected groves and would have likely been purposely sequestered in order to prevent uprooting and degradation. Archaeologically this vision may present as bifurcated management systems; *some* populations may have been stable across time, while agricultural/pastoral expansion and/or timber extraction may have encroached on others.

When tended by settled, shifting, or semi-nomadic farmers, the rural forest develops into a domesticated landscape. Certain taxa or certain plant communities are planted, selected, and protected in such a way that serves both the longevity of the desired forest resources and the economic interests of users. Often a mixture of wild and domesticated taxa gives these communities higher levels of genetic diversity and, as a result, resilience. Wilderness and farming (in whatever capacity) interface in these habitats; a forest may be divided into management zones in which grazing, foraging, and fruit and timber cultivation may be variously permitted. Typically this management strategy will yield ecological stability, showing little change over time and resisting agricultural maximization trends. While these forests may not boast the most biodiversity, they will most often sustain more genetic diversity, a thriving understory, a more variegated canopy, and a greater resemblance to a natural forest than second growth crop forests.[234] Given these outcomes it is clear that the *sustainability pathway* is most applicable. The longevity, even of a highly curated and intensely cultivated forest, indexes interests in long term gains that benefit, perhaps most directly, domestic economies and a degree of jurisdictional freedom that affords users (farmers) license to curate their environment without restriction such that it serves them.

The question now turns to what we can gather from the archaeological evidence that might illuminate the shady recesses of beliefs, values, and choices in the prehistoric past. How does resource

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[232] I am differentiating the *moral forest* from those that exist outside the sphere of human influence. A moral forest must, in other words, have its preservation or purity be imposed upon it by the people who choose to conserve it.

[233] Dillon, 1997, p. 115

[234] Michon et al., 2013, p. 5.

demand intersect with extraction and protection? How, finally, did the myriad permutations of choices culminate in the outcome illustrated in the previous chapter, where oak woodlands flourished but the pine was replaced by grassy pastures then olive groves?

3.2 *A Wooden World: Modeling diachronic resource demand*

By the Early Mycenaean period the human burden on the landscape exceeded the caloric requirements of its inhabitants, and sustaining growing communities would have undoubtedly demanded increased allotments of fuel wood and timber for the other, non-nutritional tenets of survival. Messenia is hampered by a dearth of stone construction materials, and there are no known quarries in the region save for those that supply road gravel and limestone for cement.[235] As a result, pre-industrial domestic construction would have taxed the local timber resources. Unlike the eastern Peloponnese and the Cyclades, Messenia was a "wooden world," furnished and constructed by its forests.[236] Within domestic spaces, equipped with wooden implements and fixtures, families were warmed and nourished by hearth fire, and early statecraft spawned more costly projects: monumental architecture, ship building, and war materials. The byproducts of growing trees likewise contributed to ubiquitous lifeways with the application of resin as varnishes and sealants, the consumption of tree nuts, and the supply of leaf fodder to stalled livestock over the winter.[237] Industrial production was particularly demanding of forest resources, as the metallurgy, lime production, and ceramics (vessels, roof tiles, etc.) insisted upon long-lasting, high-temperature fires for their execution.

It is difficult to imagine now just how essential a supply of timber and fuel was to daily life and survival. The forest's value was not abstracted, it was not exclusively an aesthetic or recreational space, or a space maintained for the benefit of posterity, the climate, or its ecosystems. Rather, it had an immediate, tangible utility that supplied and occupied the taskscape of its ancient users.[238] As Hughes and Thirgood (1982) point out, wood was so essential to the material world of the ancient Greeks and Romans that the word for wood (ὕλη; *materia*) came to mean "substance" or "matter" itself.

3.2.1 *Timber Use in Domestic and Monumental Architecture*

By the Early Mycenaean period, sustaining growing communities would have undoubtedly demanded increased allotments of fuel wood and timber for the other, non-nutritional tenants of survival. The lack of local stone resources would have necessitated western Messenians to utilize mudbrick as a primary construction material, possibly scaffolded by timber frames and trusses, especially if they added a second story. Unfortunately the primary focus of archaeological excavations in Mycenaean Messenia has focused on the palatial centers and citadels, and consequently our

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[235] Zangger et al., 1997, p. 556.

[236] This particular phrase, "wooden world," was borrowed from Pluymers, 2021.

[237] Hughes & Thirgood, 1982, p. 64; Stara et al., 2015.

[238] "It is to the entire ensemble of tasks, in their mutual interlocking, that I refer by the concept of taskscape. Just as the landscape is an array of related features, so - by analogy - the taskscape is an array of related activities." (Ingold, 1993, p.158).

understanding of domestic architecture and its timber demands remain uncertain. Moreover, without the introduction of firing and carbonization, the majority of construction materials breakdown and decay in time.

There is, however, some interesting evidence of domestic construction at Nichoria in the Further Province. Here a large community was established on a ridge overlooking the southern end of the Messinian Valley in the Gulf of Messenia, and, given its size and strategic position, it has been convincingly associated with one of the named towns in the Further Province listed in the Linear B documents: *ti-mi-to a-ke-e* (θέμιττος ἄγκος is "mountain glen at the frontier). According to the documents, it was a producer of flax, recipient of bronze and coastal military deployments, a center of sheep rearing, and a place from which taxes were extracted.[239] Through excavations in the 1960s and 1970s by the University of Minnesota, there is evidence enough to surmise that "the acropolis was fairly densely built over with modest houses during LH IIIA/B," however a number of houses belonging to the Middle Helladic (Unit V–1 and Unit V-2) have been identified in the "lower town" by their stone foundations.[240] In plan they conform to the MH megaron-type structures, one of which boasts an apsidal back wall. In both, a few courses of rounded (water worn) limestone and sandstone form the foundations, and mudbrick topped by timber posts and trusses form the superstructure.[241] Unit V-2, the more complete of the two, would have been approximately 8.5m by 3.5m, and the roof was likely supported by smaller diameter logs. Without a second story, these need not be large or hewn.

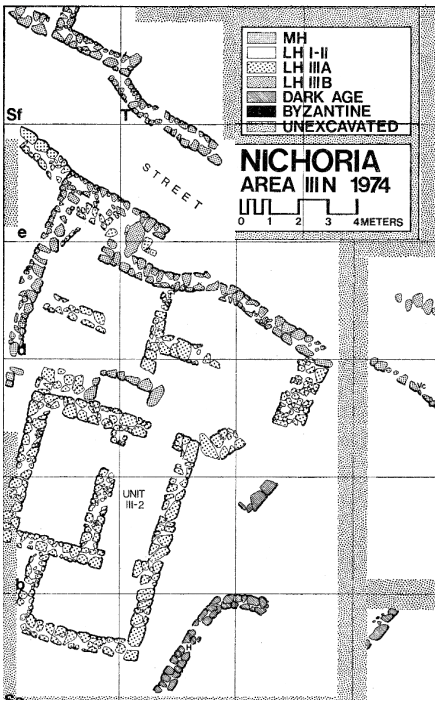


Figure 3.2 Plan of Unit III-2, an LH IIIA-B house adjacent to a main street (McDonald, 1975, fig. 2).

In the Late Helladic period, on the other hand, several multi-story rectilinear structures composed of mud brick and timber frames were uncovered. House III-2, for example, was oriented along a street and consisted of two stories; the lower seems to have been constructed with rubble wall masonry, while the upper story was constructed out of mud brick and timber framing. Without any evidence of roof tiles, wood trusses and organic roofing material (grass?) are the most likely options.[242] The weight of the second story and its floor would have necessitated large beams running horizontally across the stone walls of the lower story. These may have been smaller diameter logs tucked tightly together or larger, hewn beams of perhaps oak. Petsas House in Mycenae serves as an apt analog for this type of building construction, despite its geographical distance. Here, a large two story complex was

[239] Shelmerdine, 1981, pp. 319-325; Chadwick, 1973, pp. 276–278; flax: Na(1) 361; bronze: Jn(1) 829; taxes: Ma(-) 123; sheep: Cn(5) 600; military deployment: An(3) 661

[240] McDonald, 1972, p. 244.

[241] McDonald, 1972.

[242] McDonald, 1972, pp. 248-250.

built into a terraced hillside and was a major ceramic production center just NW of the citadel. In LH IIIA2 an earthquake and subsequent fire destroyed the building, however, it also preserved mud brick from the walls, frescoed plaster, and large hewn oak beams that were carbonized. The beams themselves were lateral beams originating from the timber framing of the west wall of Room Γ.[243] Though the houses at Nichoria were smaller, it is likely that the framework and support of the second story was similar. One apsidal house (Unit III-3) appears also at Nichoria, dated to LH IIIB, which consists of a rubble masonry socle 0.3m - 0.6m high and an off-center line of six post holes running lengthwise through the interior. Given the fact that these postholes do not follow the central axis of the building, it has been suggested that they served as a partition between living and sleeping areas in the house.[244] The holes themselves are variable in size, ranging from 0.03m to 0.08m in diameter.

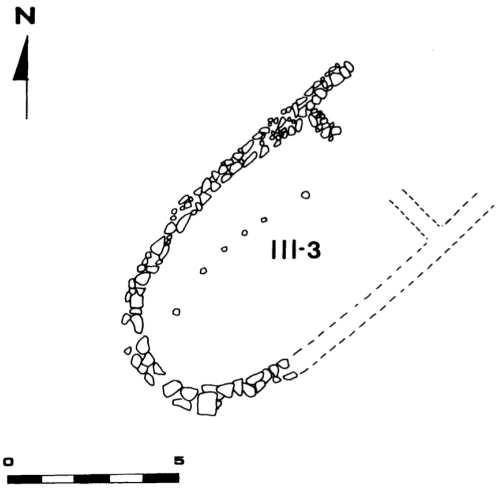


Figure 3.3 Restored plan of apsidal house (Unit III-3) at Nichoria, (Adapted by Mazarakis-Ainian from McDonald et al., 1975, fig. 3)

Malthi likewise serves as a valuable datum from Messenia, as its MH - LH "fortified" settlement contains the rubble walls of dozens of LH I houses lining the interior of a circuit wall and climbing the crest of the hill. Here, the burning and subsequent collapse of a house (Valmin's Rooms D43 and D45) has captured the remains of disintegrated mudbrick beneath destruction rubble.[245] While the earlier habitation phase, dated to roughly MH II, left traces of small apsidal buildings, the majority of the domestic architecture in the period of enthusiastic construction, LH I, were rectilinear single-story mudbrick rooms rubble socles. While these rooms were small and only amounted to one story, the destruction of the abovementioned spaces indicates that the super structures were both mud brick with timber roofing, which burned and collapsed. Stone in this location was somewhat more available than elsewhere, since the construction of the fortification wall was assisted by the bedrock outcropping on the hill. This both served as a stable foundation for the circuit wall and provided wall materials, chipped off either incidentally or intentionally for the purpose of construction.[246]

By comparison, the grandeur of the Mycenaean palaces cannot be overstated. These monumental structures housed courtyards and massive halls, embellished with frescoes and painted floors. They also contained storage, workshops, and sophisticated drainage systems. Their imposing, well-wrought facades and adornments would have inspired awe, particularly against the backdrop of much humbler settlements in their surrounds. To the larger community, however, the palaces would have had a familiar, if monumentalized, spatial syntax that elaborates on the axial room arrangements, central hearths, and flanking corridors present in mainland (though not necessarily Messenian)

[243] Shelton, 2010; beam composition and attributes: Shelton, K. 2022 personal communication.
[244] McDonald et al., 1975; Mazarakis-Ainian, 1989.
[245] Worsham et al., 2018; Valmin, 1938; Valmin, 1953.
[246] Worsham et al., 2018, p. 23.

domestic architecture.[247] This, Wright argues, would have achieved a two-pronged goal: the rulers would have emphasized their family and lineage by monumentalizing the home while simultaneously demonstrating its superiority.[248] At the Palace of Nestor in Pylos earlier forms of the palace have been destroyed, remodeled, leveled, and built over since at least the Middle Helladic, and what remains is the result of the final building phase in LH IIIB.[249] Indeed the result of this last construction project yielded a large hall with a central hearth preceded by a vestibule and a two-columned portico axially arranged (the *megaron*). This was flanked by corridors and smaller storage and production spaces and was set behind a large enclosed court. Many auxiliary buildings and complexes were also added and expanded to accommodate the growing demands of the palatial services and industries.

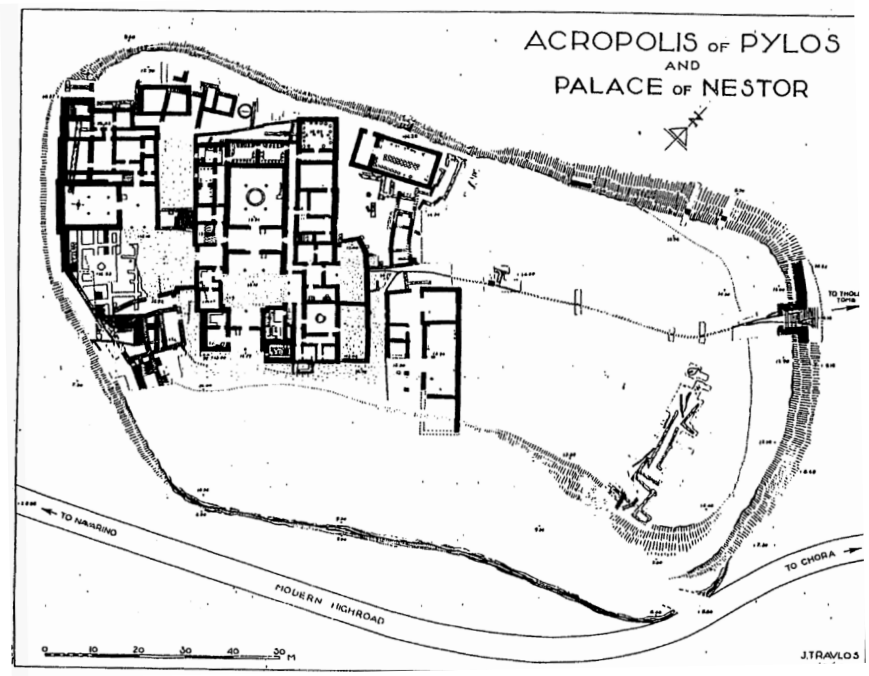


Figure 3.4 Acropolis of Pylos and the Palace of Nestor (Blegen & Rawson, 1966, fig. 416).

At least at their final phase of (re)construction, many of these palaces on the Greek mainland had analogous qualities that allow us, luckily, to make generalizations about their construction materials and techniques. For the towering exterior façades, built during the Palace's prior construction phase in LH IIIA, ashlar and ashlar-shell masonry were employed to create a smooth, neatly joined surface composed of dressed limestone and poros limestone blocks. For those without an interior ashlar face, rubble walls with mud mortar were bonded to the back of the cut blocks and finished with a thick coat of plaster to create a smooth interior wall face. In the case of the ashlar-shell walls, two faces of dressed stones were situated and filled with a rubble matrix.[250] Ashlar walls were reinforced with long horizontal timbers that slipped into beddings cut into the limestone and attached with mortises. On each wall face, the horizontal timbers were fastened to one another with transverse wooden chases, which secured the wall faces to one another and provided interior support. The long horizontal

[247] Wright, 2006b.

[248] Wright, 2006b, p. 61.

[249] There is evidence for Early Helladic occupation of the site, however no architecture from that period has been accessible/excavated.

[250] The abundance of large limestone blocks is curious here, since no quarries have been identified in the area. Evidence from the PRAP survey suggests the site of Gargalianni as a possible source, which is 23 km north of the palace (by road).

timbers would have subsequently doubled as window and door lintels (Figure 3.5). For the majority of interior walls, all built in LH IIIB, ashlar masonry was substituted with rubble masonry, likely reinforced with a timber framework in the fashion of ξυλοδεσιά.[251] Horizontal beams and transverse chases create a 3-dimensional framing into which rubble is stacked. This style of construction is evident elsewhere on the mainland, as can be observed in the wall of the South House, Tsountas House, the House of the Columns, and the west wall of the ramp at Mycenae as well as in the east wall of Storeroom XLVI atTiryns.[252] Rather than bedding cuts, as would be expected in ashlar masonry, grooves in the walls mark the outlines of timber framing that has long rotted away. On account of the "abundant accumulations of clay from disintegrated bricks" throughout the palace, it is feasible to assume that the upper floor(s) were constructed with mudbrick upon the stone walls of the lower story.[253] This material would have reduced the weight of the upper levels and, without evidence of a tiled roof, would not have had a comparable weight burden themselves. Wood framing at the floor and ceiling level would have been likely, as well as joists supporting the flooring at the second (and third?) level (Figure 3.6).

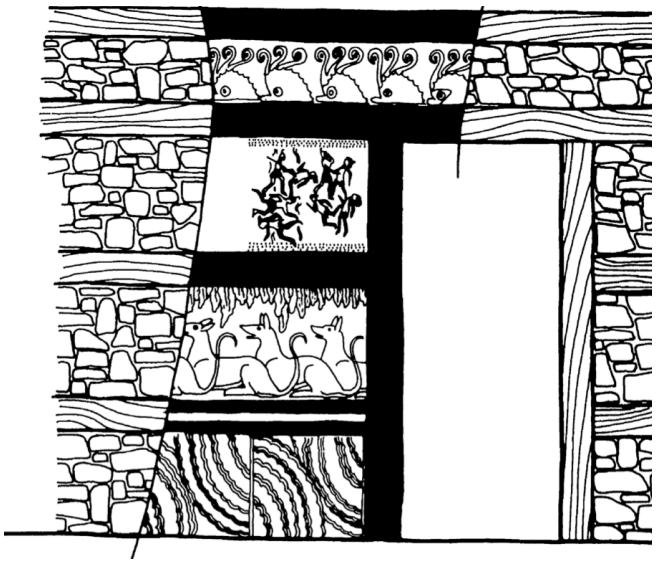


Figure 3.5 Fresco reconstruction, Room 64, northeast wall, showing the horizontal beams beneath the plaster (adapted from Nelson, 2001, fig. 54).

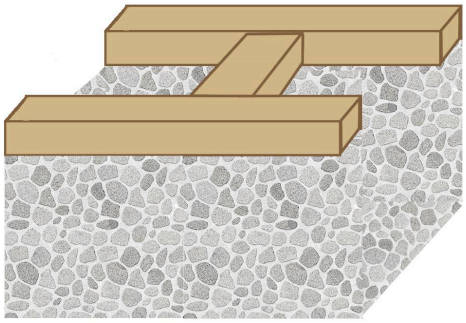




Figure 3.6 Elevation: Main Building, reconstruction of northeast facade (Wright, 1985, fig. 10).

[251] Blegen, 1965; Blegen & Rawson, 1966; though he challenges the presence of the *xylodesia* style at the Palace of Nestor: Nelson, 2001.

[252] Nelson, 2001, p. 167.

[253] Blegen & Rawson, 1966, p. 37.

Some elements of the palace would have been entirely composed of timber, particularly the wooden columns, roofing, joists, the balcony overlooking the throne room, and the porch that extends over the court in front to the megaron.[254] Moreover, given the distances between the walls and the columns, across which these large beams would have rested, it is clear that the beams would have been necessarily long. The extant column bases that dot the floor plan of the LH IIIB palace illustrate the extent of the timber superstructure, which passed from wall to column, column to column, and wall to wall. The longest distance a beam would have had to span was over room 46, which yields no indication of mediating columns. In this room the distance between walls was 6.23 m, a limit avoided elsewhere by strategically placed supports that only required beams of a 2.81 m maximum length. Not only were these timbers long, but in order to maintain structural integrity they would have also been "stout tree trunks" of 0.23m - 0.39m diameters.[255] Three such carbonized wood samples were in fact discovered during Blegen's excavations, which had burned and fallen into room 44, the vestibule in the northern area of the court with two columns. Though their length can only be inferred by their placement in the space (wall to column: ca. 0.75, ca. 1.90 and 0.70 m), their thickness was preserved and is as follows: ca. 0.13m - 0-14m square, 0.27m x 0.35m and 0.13m x 0.26m. While these beam fragments were not analyzed in the lab, 14 other fragments were sent first to the University of Minnesota, then to the Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology for species identification. Half of these specimens were identified as oak, and the other half were conifers, likely pines.[256] Indeed it is safe to assume that the largest architectural elements were oak, given its size and strength. In the final destruction of the palace, a fire ripped through the structure and burned the vast majority of the wooden superstructure, and, fueled by the wood and the olive oil stores, it reached such a temperature that gold ornaments were melted into lumps.[257]

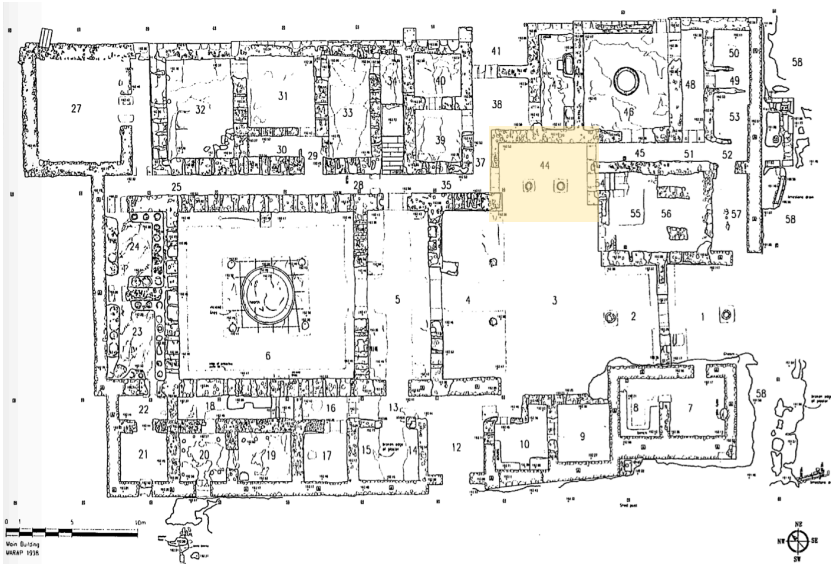


Figure 3.7 State plan: Main building; room 44 highlighted in yellow (from Nelson, 2001, fig. 14; highlighted by author).

Messenia boasts archaeological evidence of not one, but two monumental administrative and industrial centers, as Iklaina stands just about 5 km southeast of the Palace of Nestor and contains

[254] Blegen & Rawson, 1966, pp. 38-39.
[255] Blegen & Rawson, 1966, p. 39; Nelson 2001, p. 72.
[256] Nelson, 2001, p. 71, table 6.
[257] Blegen & Rawson, 1966, p. 40.

monumental and even Cyclopean architecture reminiscent of other major centers on the mainland. In the foothills of the Aegaleon Ridge, east of the Bay of Navarino stands a Mycenaean settlement, first occupied in the MH, with three distinct sectors: administrative, residential, and industrial. The earliest building has been dated to LH I/II, however the majority of the extant architecture was undertaken in LH IIIA2, contemporary with the construction of the ashlar facades at the Palace of Nestor and its earlier interior iteration.[258] In the administrative center, two monumental buildings were constructed, the largest of which, a 2+ story building, standing on a massive 24.30m (l) × 8.20m (w) x 4m (h) Cyclopean platform (Figure 3.8). Like the contemporaneous building style at Pylos, the walls were ashlar blocks coated in thick plaster.[259] The destruction layer also bore burnt mudbrick, likely from the second story, and carbonized wooden beams.[260] Though this administrative center was not a palace in the traditional mainland sense, boasting Linear B archives and a megaron, it had many of the trappings of Mycenaean stateliness, such as the painted figural frescoes that were scattered throughout the area of the Cyclopean Terrace after its destruction as well as well wrought roads and sophisticated drainage systems. The ashlar walls were most likely secured with horizontal timbers, and the trusses and joists that supported the second floor and roof were almost certainly timber as well. In fact, one of the recovered ashlar blocks appears to possess a bedding cut, onto which a horizontal beam would have been affixed. Two charcoal samples selected for C 14 dating by the excavators have been identified as belonging to the construction debris from the large building on the Cyclopean platform (CTB) and are both oak wood.[261] This evidence foregrounds the probability of these construction timbers being, optimally, oak.

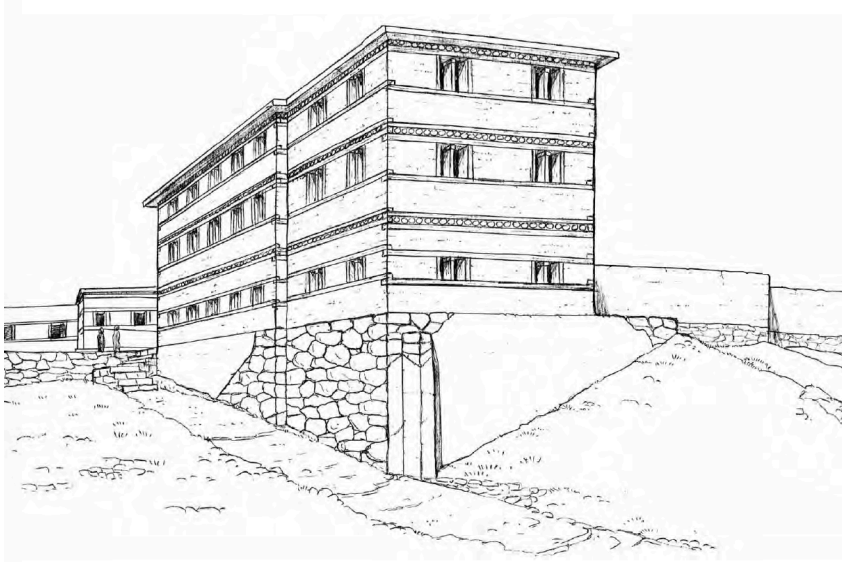


Figure 3.8 Artist's reconstruction of the Cyclopean Terrace Building from the northwest (illustration by Yannis Nakas; from Cosmopoulos et al., 2018, Plate IV)

The latest additions to the settlement are in the industrial sector and were built in LH IIIB. These rectilinear structures were constructed over pre existing buildings (with a different orientation) and were roughly contemporaneous with the construction of the Northeastern Building (NEB) at the

[258] Cosmopoulos, 2021.

[259] The building was destroyed in LH IIIB (like the Palace of Nestor) and the ashlar blocks tumbled in front of the platform. Several have been recovered (Cosmopoulos, 2021, p. 275).

[260] Cosmopoulos et al., 2019, p. 891.

[261] Cosmopoulos et al., 2019, table 2.

Palace of Nestor, which served as a clearing house, as well as the wine magazine.[262] The site of Iklaina has been largely coupled with the Linear B toponym *a-pu2*, which is one of the nine towns of the Hither Province administered by the palace at Pylos.[263] These documents attest to the disbursement of bronze to seven named smiths at Iklaina, all of whom receive 3 or 4 kg of bronze from the palace.[264] They also contribute bronze (scrap) *to* the palace for ships and the points of arrows and spears as well as gold.[265] They seem to be taxed in certain commodities (possibly spices), while their bronze smiths were awarded an exemption.[266] It seems, therefore, that this was a major industrial center at which metallurgy was taking place.

These two major administrative centers, just 5 km apart, would have cost the timber stocks dearly in the (re)construction at the height of the Mycenaean period. The construction of monumental architecture, both in its impressive ashlar facades and well-engineered timber-framed interior walls, demanded thousands of meters of long, sturdy beams and timber reinforcements. The exterior ashlar walls of the monumental administrative building on the Cyclopean Terrace *alone* would have required an estimated 2,250 feet of squared wooden timbers, between 10 and 20 cm thick. If we factor in the joists supporting the second (and possibly third) story, this number balloons to 7,050 or 11,850 feet of 10 cm thick timbers (roughly 250 oak trees). Moreover, this estimation doesn't even account for the roofing materials, columns, balconies, and interior walls. Beyond the costly construction programs at Iklaina and the Palace of Nestor, the same Linear B documents that provide us the name *a-pu2* also attest to eight other towns in the Hither Province with potential for similarly engineered monumental structures. Algorithms and statistical methods that detect connectedness between the villages and the palace have been deployed by Carothers and Cherry.[267] These, but particularly the former, reveal four tiers within the settlement hierarchy in the Pylian kingdom; such ranked settlements have further been confirmed through archaeological and survey data by Michael Cosmopoulos and through taxation and allocation records by Carothers.[268] At the top was, of course, the palace at Pylos, which governed both provinces from its strategic position on Ano Englianos. The second tier, to which *a-pu2*/Iklaina belongs, is composed of the 9 towns listed always in the same order in the tablets, which appear to be regional centers administering the agricultural and industrial projects therein. The third and fourth tier are small villages to which the palace paid less attention. It is the nine

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[262] Though the NEB has long been considered a workshop with a shrine, Bendall has recently put forward a convincing argument that goods and finished products cycled through this space as they moved in and out of the palace (Bendall, 2003).

[263] First suggested in Hope Simpson, 1981; later affirmed in Davis et al., 1997; Carothers, 1992, and Cosmopoulos, 2006.

[264] Jn(1) 693

[265] Jn(1) 829; Jo(-) 438

[266] Ma(-) 124

[267] Carothers (1992) used digraph theory, and Cherry (1977) used Non-Metric Multidimensional Scaling (MDSCAL) to measure interactions; Cosmopoulos, 2006; Cherry, 1977.

[268] The Ma tablets from Pylos record tax assessments whose varying volumes of the commodities, Carothers argues, reflects the varying settlement sizes. Cosmopoulos is skeptical of this correlation, since we don't know what many of the commodities were. Carothers also uses the documents that distribute fattened pigs (Cn 608) and wine (Vn 20) to various towns in support of the same site-size correlate, however, as Cosmopoulos points out, "we don't know the criteria used for the calculation [of the distribution]" (Cosmopoulos, 2006, p. 214).

regional centers that would have, in all likelihood, a propensity for monumental construction, as is the case at Iklaina.

Though the mapping of the geographic locations of these towns has been exercising Mycenaean scholars for over 50 years, some have been correlated with known sites (mostly unexcavated) with moderate certainty. Beyond *pu-ro* (the Palace of Nestor) and *a-pu2* (Iklaina), it has been suggested that the toponym *pa-ki-ja-ne* may have been attributed to a town at/near Khora:Voilomidhia and *a-ke-re-wa* to Korifasio:Beylerbei.[269] All three of the abovementioned second-tier towns lay within the pollen catchment area, prompting the possibility that one *more* site had similarly massive timber demands for the sake of their own monumental structures.

The administration of these massive construction projects rarely appears in the documents. Very small, skilled labor groups composed of *to-ko-do-mo* "builders", likely temporary corvée assignments, were dispatched to various small and large settlements in the kingdom.[270] Given the size of these groups, generally 1-4 people, it is unlikely that the building program was of a monumental scale and similarly improbable that the palace would allocate resources to the cultivation of the stately aesthetics of subordinate centers. Giulia Paglione has convincingly advocated for an alternative reading of these assignments: rather than constructing a building, these *to-ko-do-mo* were constructing or repairing roads. Specifically, in PY An(6) 35 the builders were charged with the care or construction of the roads that connected the major centers, Pylos and Leuktron, with the smaller villages of *me-te-to* and *sa-ma-ra*.[271] Another, more inscrutable text offers an isolated attestation of the materials gathering for a construction project. In PY Vn(-) 46 and its continuation on PY Vn(2) 879, various tallies carpentry items, such as beams (*ta-ra-nu-we* θρήνυες -> θρᾶνος), roof beams (*e-ru-mi-ni-ja* ἐλύμνιαι), and columns (*ki-wo-qe* κίων).[272] The header, however, is missing, and consequently the purpose of these items is unknown. The tallies are without a complementary ideogram, so it is unclear what units are being counted. One column and two roof beams, for example, may generically be understood as assembled oak trunks, yet the *quantities* are somewhat puzzling.

3.2.2 *Timber for the Construction of Ships*

Beyond the limits of the inert architectural remains, which defiantly resist time's plunderous campaigns, the movements of people are evident only in silhouette. The contours of maritime trade/travel and the conveyance of military combatants are insinuated only by the breadth of the kingdom's frontiers, the investments in weaponry, the presence of imported metals and special objects,

[269] Cosmopoulos, 2006; Davis et al., 1997.
[270] PY An(-) 18 and PY An(6) 35.
[271] Paglione, 2023.
[272] Ventris & Chadwick, 1973, p. 349.

and the artistic and technological engagement with the "Mycenaean koine."[273] The materiality of sea travel and military encampments, however, are lost. With respect to the burden of these movements on the landscape, certain details can be inferred.

With respect to settlement patterns, the focus on and access to the coast ebbs and flows. In the Early Helladic the scattered Messenian settlements largely dotted low lying areas at the coast and in large river valleys. Populations were low, but demonstrations of connectivity, such as the possession and manipulation of bronze and the acquisition of Minoan pottery, are discernable. At the location where the Palace of Nestor would later sit, EH III walls enclose a small room with bronze pieces and a clay crucible were recovered.[274] As has been mentioned previously, neither copper nor tin occur naturally in Messenia, and their combination at Epano Englianos indexes trade channels that close the gap between the southwestern Peloponnese and Cyprus, Uzbekistan, and/or Turkey. The nucleation of habitation sites on waterways makes it tempting to infer some variety of engagement with riverine or maritime trade, travel, or transport, but evidence of water craft construction within the PCA is yet absent. Settlement patterns shift dramatically in the Middle Helladic; where once 31% of sites were coastal, in the MH periods that number drops to 15%, despite the overall site composition having doubled, and more than two thirds of them are more than an hour's walk to the coast.[275] Some imported pottery appears (from

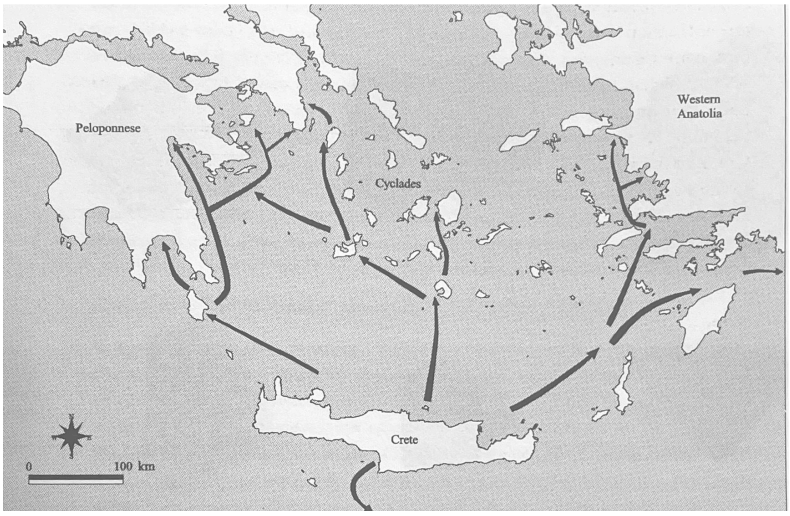


Figure 3.9 Dendritic pattern of maritime trade centered on palatial Crete (Broodbank, 2001, fig. 121).

[273] Frontiers: based on the Linear B evidence, the Palace of Nestor had gained control of the entirety of Messenia, which was populated with many, likely independent, towns and settlements prior to the Pylian incursion. The implication here is that either by violence or by the credible threat of violence, these independent settlements were subsumed under palatial domain (see Ch. 2 for a more detailed discussion of the features of the Pylian geography and frontiers); weaponry: not only are weapons and defensive garments found in mortuary contexts, but the documents also record manufacturing orders and consignments. Additionally, the physical remains of hundreds of stone and bronze arrowheads at the palace demonstrate the ubiquity of projectile weaponry (PY Jn series; Bendall, 2003); imports: neither copper nor tin sources are found in Messenia, and were likely imports from the vast Mediterranean trade network, from which Cypriot copper and central Asian tin were sourced. Examples of imported finished objects come from the Grave of the Griffin Warrior, which housed dozens of Minoan carved seals and gold signet rings, a carved ivory pyxis, and other gold objects and ornaments; koine: The artistic and technological attributes that are common to Mycenaean settlements include the megaron, Linear B, frescoed wall paintings, pottery styles, certain religious practices/paraphernalia (rhyta, processions, etc.), and clay figurines (see Bennet & Davis, 1999 for an overview of the process of Mycenaeanizing).

[274] Davis & Stocker, 2006.

[275] According to Tartaron a "coastal" settlement is within 5 km of the water's edge (Tartaron, 2013); McDonald & Hope Simpson, 1972.

Crete) at the Epano Englianos ridge and elsewhere, but McDonald and Hope Simpson (1972) proffer "all indications point to the conclusion that these people were fundamentally uninterested in trade and other outside contacts."[276] Of course imports from Crete and metals penetrated their otherwise inland domains, likely mediated by their intra-Peloponnese contacts.[277] The Middle Bronze Age is precisely the moment at which the Minoans restructured the previously east-west tradeways of the Aegean (from Aegina, through the Cyclades, to western Anatolia) to a "dendritic" north-south arrangement dominated by palatial Crete.[278] As time went on, focus shifted once again to the coast and its promise of connectivity. Within the PCA seven new habitation sites dot the bayshores, all less than 5 km distance from the water.

The bay over which the administrative center looks is particularly suited to connectivity and cosmopolitanism characteristic of the Late Bronze Age in the eastern Mediterranean. It is a large, sheltered bay with sandy beaches and, up until LH II, ample tree stocks fit for ship building. Based on contemporary analogs of *seafaring* boats, pine wood and, most preferred, fir wood was marshaled for the planking that formed the hull, and oak served as a strong keel and rigid tenons that affixed the curved hull planks (strakes) to one another.[279] Moreover, two rivers fed the bay, making the transport of materials from greater distances uncomplicated. The entirety of the western and southern boundaries of the kingdom are coastal, and sea travel between coastal loci would have shortened the distances between them efficiently. A relationship with Zakynthos evidenced in the documents would have also required maritime competency, and the caloric potential of the Ionian sea would have likely drawn Messenians into fishing vessels.[280] Finally, Palaima (1991) assembled a list of nautical-sounding personal names that appear on the tablets, one of which comes from Pylos: *o-ti-na-wo* "ship-starter."[281] In the Mycenaean period, the presence of ships, in other words, should be assumed; families or communities living in coastal settlements could have pooled their skills and resources to construct a small vessel for fishing journeys and inter-settlement exchange. Yet no evidence has been preserved that bears witness to the maritime engagements of *private* individuals, according to available archaeological data.

As is customary, the gravitational pull of (relatively) abundant palatial data fixes our gaze on state-level maritime operations. Here indeed we have been fortunate enough to have recovered three documents that testify to the conscription of rowers from various coastal settlements as well as those sourced from powerful individuals (the *lawagetas* and, perhaps, the *wanax*).[282] In accordance with the typical proportional taxation system through which the palace mobilized the commodities in the Ma, Cn, and Vn series, these coastal towns supplied a labor force commensurate to some metric, perhaps population size or, as Ventris and Chadwick (1973) and Killen (1983) supply: landholders who owe

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[276] McDonald & Hope Simpson, 1972, p. 134.

[277] Davis and Stocker see this relationship differently and note the "important, if generalized, synchronism between the Middle Bronze Age Peloponnese and Crete" (Davis & Stocker, 2006, p. 104).

[278] Broodbank, 2000, pp. 356-359.

[279] Uluburun: Bass, 1986; Pulak, 1988). Preferred taxa for ship construction: Monroe, 2007; Meiggs, 1982; Veal, 2017.

[280] Zakynthian (chariot) wheels listed in PY Sa(1) 751 and PY Sa(1) 787.

[281] PY Cn 285; Palaima, 1991.

[282] PY An 1, PY An 610, and PY An 724; Palaima, 1991, pp. 285-289.

service as a consequence of their status as landed.[283] According to Killen (1983), these texts parallel Ugaritic conscription documents that, just as in this case, called-up a number of individuals from five villages for service on a naval fleet.[284] And just like other Mycenaean taxation documents, there is a register of labor owed (*o-pe-ro* ὀφείλω).[285] The number of vessels manned by these recruits can be inferred from the first document, PY An(4) 1, which obliges a total of 30 individuals from five coastal villages to row to Πλευρών. This is plausibly *one* vessel with a particular destination in Aetolia as its terminus. Given the aggregate number of rowers from all three tablets, the number of vessels manned would be 20, a formidable fleet. The *raison d'etre* of the vessel itself is salient but unknown here. The ship may have served to transport the combatants (rowers) to a destination, or it may have itself been an instrument of war in naval battles.[286] In the latter case, speed would have been imperative, and the lighter weight fir wood would have been targeted for hull construction.[287] For deployments, however, the pine or, as was the case in Britain, oak wood may have been employed, as these would have been more durable but much heavier materials.



Figure 3.10 Verso of PY An 724 with inscribed image of a boat (pink box).

Traces of commercial shipping are, regrettably, scant in records, and, as was mentioned above, the physical evidence of maritime trade exists only in the assumed object histories of the recovered exotica. Consequently, it is difficult to surmise whether these profitable trade programs were the domain of the state, the private individual, foreign merchants, or some mixture thereof. Sauvage (2017) observes that in Ugaritic, Egyptian, and Hittite political contexts, the

[283] The relationship between the rowers and landholdings is indicated by the terms *ki-ti-ta* (settlers), *me-ta-ki-ti-ta* (new settlers), and *po-si-ke-te-re* (foreigners) that accompany the place names and tabulations.
[284] Killen, 1983.
[285] PY An 724.
[286] Waschmann problematizes the oft ignored equation of oared ships with warships, an assumption exacerbated by the representations of bow-projections and keel lengthening in Mycenaean art that are mistaken for rams. Not only did these "spurs" serve purposes other than ramming, but oared ships were mobilized for overseas commerce, pageantry, and migration (Wachsmann, 1998, pp. 159-161).
[287] Theophrastus, *Historiae Plantarum,* 5.7, 1-3; since fir rarely grows at elevations below 800 m, this timber resource would have required transport from, perhaps, Taïegetos, Arcadia, or beyond the Greek mainland (via maritime trade).

state's vital interest in maritime trade motivated them to assume control over it. She argues that merchants leased ships from the state, and that the harbors themselves were likely also royal property. While no concordant evidence exists anywhere in the Mycenaean mainland, the logic of the argument can be easily applied. The overseas transactions, particularly those that facilitated the acquisition of metals, were highly valuable, and the transactional inputs (domestic perfumed oil) and outputs (foreign metals) are commodities controlled by the palace, evidenced by the on-site unguent industry and the 20 bronze distribution documents.[288] It is also possible that the Pylians were tapping into, perhaps, a Canaanite trade network, rather than investing in their own vessels, since personal objects sourced from the mainland were found aboard the ship that wrecked at Uluburun, possibly indicating the ethnic identity of the crew.[289] Indeed the commercial control apparent in the documents and preferred elsewhere in the eastern Mediterranean still accords with this model; as is evidenced in Old Babylonian texts, the state may have taxed the cargoes and/or merchantmen, allowing them to supervise and govern imports/exports and profit off the use of the bay without taking on the substantial cost and risk of launching a palatial fleet.[290]

Surprisingly, despite the intricacies and meticulousness of the administrative documents, no testament to the investment in merchantmen or naval vessel construction, cargoes, or trading transactions have been identified. The mixed-media masterpieces that were chariots were recorded in detail, including the labor force mustered in their construction, yet no comparable records that index the objectively more technologically complex, more expensive enterprise of shipbuilding exist.[291] One text in the Jn series, which deals with bronze, features the header:

PY Jn(1) 829

1. jo-do-so-si , ko-re-te-re , du-ma-te-qe ,
   So they, the *ko-re-te,* the religious superintendents,

   -e-we-qe

2b. po-ro-ko-re-te-re-qe , ka-ra-wi-po-ro-qe , o-pi-su-ko-qe , o-pi-ka-pe-
   the vice-*ko-re-te,* the key-bearers, the fig-supervisors, and the supervisors of grain processing

3. ka-ko , **na-wi-jo** , pa-ta-jo-i-qe , e-ke-si-qe , a3-ka-sa-ma
   contribute bronze for ships(?) and points for arrows and spears.

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[288] Shelmerdine, 1985.

[289] Seven Mycenaean vessels, a sword, an amulet, and a pin perhaps belonged to a Mycenaean on board, rather than the cargo; Bachhuber, 2006; Pulak, 1988; Shelton, K., personal communication 2023; Mycenaean trade objects were also likely on board, however they would have been perishable (like perfumed wool textiles and linen).

[290] Monroe, 2007, pp. 14-15.

[291] PY Vn 10 lists saplings delivered to chariot workshops for the manufacture of axles; PY Sa series (35 total tablets) record chariot wheels. Elsewhere in the eastern Mediterranean, documents record the assembly and provisioning of ships. Some examples include: one of the Amarna letters a Cypriot king reminds an Egyptian king that he is sending in a shipment a "beam for a ship"; in the Hittite archives a letter from Ramses II requests that the Hittite royal carpenters replicate the Egyptian ship style from drawings (Sauvage, 2017); The Egyptian queen Hatshepsut claimed to have shipped two obelisks on a 60m barge and King Snefru requested "40 galleys of cedar" from Lebanon in 2600 BCE and claimed to have constructed a 50m barge (Monroe, 2007, pp. 4-5); an Ugaritic texts allocated 540 shekels of silver to the construction of a ship, and a 12th c. papyrus from Egypt indicates the prices of shipbuilding timber (fir, cedar, pine, other conifers) (Monroe, 2010).

+16 lines of contributions (only those from *ko-re-te* and vice-*ko-re-te* listed).

It appears that scrap bronze is being collected from the 16 towns of the Hither and Further provinces, rather than distributed, as is the case for the rest of the bronze documents series. The arrow and spear tips translation is affirmed by other tablets, but the translation for *na-wi-jo* is less certain. Some iteration of ναῦς (ship) or νήιον (ship-timber) is just as viable as ναός (temple), and it is curious that, were the νήιον reading correct, the only mention of ship construction be in the context of metal appropriation, as opposed to the more intuitive timber and labor group mobilization. Palaima asserts that this reading is unequivocally incorrect and notes the preponderance of religious titles in the header that index a "temple bronze" interpretation over that of "ship bronze."[292]

Another document proves more promising, given its reference to one or more shipwrights/carpenters, *na-u-do-mo*. The tablet PY Vn(1) 685 is headed with this term, and subsequently lists 12 named individuals, alongside whom the count "1" is listed without an ideogram. Presumably, given the effort to name each one in lieu of simply counting □(MAN) 12, those listed possess a higher status than a labor group, and may possibly be a team of skilled carpenters working under a shipwright, or a survey of the shipwrights under whom a skilled, if unnamed, team would be supplied.[293] With a team of 12, Palaima reports, a Bronze Age ship could be constructed in approximately six months, making it likely that this tablet records one skilled labor group assigned to the construction of one ship (at a time).[294]

In either case, we can confidently assume that the construction of ships, whether or not they were state supplied naval vessels or merchantmen, would have been an essential enterprise, if not for long-distance travel then for coastal sojourns and fishing journeys. The cost to the local resources, thus, can be roughly tabulated based on the presumed ship anatomy, gleaned from technological standards of roughly contemporary shipwrecks. In the Bronze Age there was a shell-first approach to construction, which required the form of the hull to be shaped by the curved planks (called *strakes*), affixed to one another with pegged mortises or sewn together. Internal framing is added afterward in order to reinforce the existing form. This method precluded these ships from being scaled-up, and the size limit for *seaworthy* shell-first ships was about 16 m, the length of the ship that

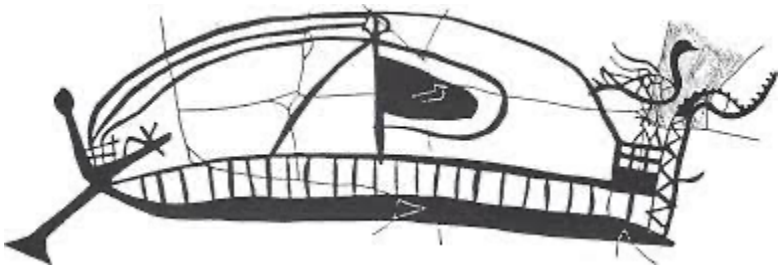


Figure 3.11 Decoration on a pyxis found in a tomb at Tragana, Pylos (Late Helladic IIIC) (from Wachsmann, 1998, fig. 7.17).

[292] Palaima, 1993, p. 295.
[293] Palaima, 1993, pp. 287-288.
[294] Ibid.

sank at Uluburun.[295] Another trading vessel that wrecked in the LBA, the Cape Gelidonya shipwreck, measures approximately 10 m in length, providing a minimum value for a seaworthy and commercially viable merchantmen ship at the time.[296]

Monroe (2010) estimates that each side of the hull would have been composed of seven strakes (14 total), which curved downward into the keel. These strakes would have been the length of the ship, or shorter planks may have formed composite members. Based on the hull fragments recovered from the Cape Gelidonya shipwreck, it appears the strakes were between 10 and 15 cm wide, reflecting the range in diameters typical to the conifer species (in this region, it was likely pine) chosen for these members.[297] Splitting a log with wood, antler, or metal wedges easily supplies long, uniform planks that require little subsequent hewing. The low moisture conditions in Greece, however, stimy the radial growth of pines and firs, making their trunks slender and capable of producing only two or three planks.[298] Additionally, the trunk tapers toward the top, so beyond the first 20 ft, a maximum of one plank could be obtained. The hull construction alone would have thus required *at least* 7-9 pine trees.[299] After ~1900 BCE, sailing technology was widely adopted in the eastern Mediterranean, and we can assume that, at least for the large naval vessels, another tree, likely pine, would be summoned to serve as the mast (15 m).[300] Attached was a yard and boom that jutted perpendicularly from the mast and supported the sails. These were quite long, possibly longer than the mast itself, and the upper and lower members would have each required a long pine trunk. To seat the rowers, 15 benches would have been installed that closed the distance between the walls of the hull and reinforced it. These may have been at a lower level, the rowers gallery, with the full decking and deck beams set above. At a width of 3-5 m, the internal architecture of the ship would have demanded, roughly, 4 or 5 more pine trunks, split. The keel, gunnels, and pegs were preferably oak (or other hardwoods for the latter two elements). Theophrastus maintains that the strength of oak is practical in its use for the keel, as it can withstand the violence of hauling, though it should be noted that a *cedar* "keel-plank" of 28 cm wide was identified on the Uluburun shipwreck.[301] Given the latitudinal stress on this central component, a single piece would have served better than joined keel pieces.

Forgoing the consideration of oars, cabins, tillers, rudders, cleats, sternposts, and bow projections, the list above illustrates how demanding ships were of forest resources. Of local pines one ship would have required 16-19 trees in addition to 1-2 oak trees. With an estimate of 20 vessels for the fleet manned in PY An 610, roughly 350 pine trees and 30 oak trees would have been felled in order to raise the fleet, more for repair and upkeep. It is probable, also, that coastal villages near the bay had at

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[295] Monroe, 2007, pp. 11-13; later shipwrecks with the same approach to hull construction, such as the Ma'agan Mikhael and Kyrenia shipwrecks, seem to be constrained by the same limitations and share dimensions with the Uluburun shipwreck.

[296] See Monroe (2007) for further discussion on these dimensions and their relationship to the "the tyranny of distance" and other trade implications; Bass et al., 1967.

[297] Bass et al., 1967, pp. 50-51.

[298] Koulelis & Petrakis, 2023.

[299] Error in splitting or inferior growth patterns in the trunk can make the process of splitting less efficient, and otherwise usable sections of wood may be wasted. The range provided reflects splitting ideal trunk sections *without* error.

[300] Papyri from Egypt listed the prices of ships timber record masts of both 20 m and 15 m length (Monroe, 2010, p. 25).

[301] Theophrastus, *Historiae Plantarum,* 5.7, 1-3

least one small craft at their disposal, either community constructed or belonging to an industrious tradesman or fisherman.[302] In the Late Helladic period seven habitation sites curve around the shores of the bay; even with vessels half the size of those in the palace's fleet, 130 more trees would have been felled to supply these local communities with small-scale sea access. Moreover, even with repairs and careful care, the porous pine wood is prone to rotting, and would need replacement at least every 10-15 years. Over the entirety of the sea and trade-centric Mycenaean period, the vessels crafted in the pollen catchment area alone would have cost the local forests over 15,500 pine trees and over 1,300 oaks.

The burden of procurement of these supplies, particularly those deployed in the installation and upkeep of a navy, would have naturally been a critical political imperative. Meiggs (1982) catalogs the political ecology of Athenian naval warfare in the Classical period and the difficulty the polis faced when raising large fleets of triremes in the context of mercurial trade relationships with timber-rich states. Much later, anxieties over securing ship building materials partially incentivized, or at least justified, British colonialism in the west. Supplying the ship carpenters of the royal navy in England was a constant concern during the period of dwindling wood supply in the 17th c. CE. Communities traditionally held common rights to the forests that furnished their daily needs. In these same woods naval carpenters would scour the growth for perfect timber trees, bent or split to serve particular forms and dimensions of the skeleton, planks, and fastenings. When scarcity panic gripped the state, conservation legislation withheld rights from private citizens to collect fuel wood and timber while protecting the felling rights of naval carpenters, particularly in regions of the forest adjacent to waterways. The legal measures that shipbuilders were permitted to circumvent, like privatizing and selling forest land and enclosing royal forests with fences, were installed in many cases *for the sake of* the protection of naval supplies. The state's imperative was to secure timber for the navy and royal merchantmen above all other potential profits and entitlements. Ultimately, the domestic supply problems, or more specifically the *threat* of domestic supply problems, politically and economically rationalized colonial expansion in the New World. Promoters of the colonial enterprise took various tacts, promising lower population on the island by shifting groups to the colonies, circumventing intra-European tariffs and importing wood from colonies, and outsourcing fuel burdened industries, like iron and glass work, thus saving the domestic stock for, above all others, the shipwrights.[303]

3.2.3 *Warfare and Timber*

In many ways this chapter takes a parallel course as Meiggs' incomparable survey of timber usage in the ancient world, *Trees and Timber in the Ancient Mediterranean World,* where he explores categories of human activity and statecraft that rely on a habitually overexploited resource. Given the temporal scope of his project, he concludes, quite convincingly, that warfare was more costly to timber resources than shipbuilding in Greece and Rome. Between the construction of large forts and camps,

[302] Among the villages from which rowers were called up in An 610, *ro-o-wa* supplies the largest labor force. It has been suggested that this village is the main port of the Pylos (Palaima, 1993, p. 285). Given the volume of available rowers, it might be plausible that this village had more than one, if not an abundance, of boats.
[303] Pluymers, 2021.

long-lasting sieges, war machines, clearing forests for advantage in battle, bridges and roads, and fuel, this oft overlooked expense had catastrophic effects on local forest ecologies.[304] Indeed in the Bronze Age many of these costs may have been comparable. Clearing the forest to create a battlefield without cover is a prudent measure, and terrestrial travel through the dense vegetation would have been difficult without any impact on the plant communities through which they cut as they consolidated the Messenian territory. By the early Mycenaean period, the palace of Nestor was fortified, possibly among other urban centers in Messenia, in order to thwart siege attacks, and chariots of (presumably) war were crafted in large numbers in the Late Helladic period.[305] Simply put, it is reasonable to assume that warfare in Messenia likewise had deleterious effects on the various ecologies.

It is wise at this juncture to contextualize these combat scenarios, as the deployment of the historical sources that outfit our understanding of ancient warfare risks homogenizing the tools and tactics of war. The defensive investments at these settlements are rare. While the Palace of Nestor and Malthi were fortified in the Shaft Grave Era, other fortifications are seldom seen archaeologically.[306] This is not to say that wooden walls were not constructed; they very well may have ringed every major center in the region prior to their annexation by the Pylians. The evidence simply suggests that the defensive fortifications would have been more easily overcome than, for example, the Cyclopean walls of Mycenae and Tiryns in the Argolid. In other words, we can't assume that a siege of Iklaina would have mirrored that of Plataea during the Peloponnesian War, which required an entire year and massive timber structures.[307]

The other important context for timber use in Bronze Age warfare is the infrequency or ephemerality of the resource stress. Were armies to carve roads into the wilds, clear vegetation for battlefield advantage, or even construct timber palisades, the impact on the environment would be temporary and reversible. While terrestrial warfare may have been constant, the pressure on any one landscape would be occasional. Given the temporal scope of this project, it is doubtful that the observable long-term trends in the region's vegetation history are a product of static episodes of high timber usage. Rather, it is the habitual use-patterns over many generations that shape these observable outcomes.

3.2.4 *Domestic Fuel Use and Industrial Pyrotechnologies*

Unlike timber, which is durable and involves only periodic withdrawals, wood fuel exists to be destroyed, and as such it is an unrelenting burden on the forest ecosystems. In tandem with population growth so too did the appetites of the hearths and the woodcutters' bounty swell. Sustaining life within the pollen catchment area, at the most basic, unembellished level, demanded 4 to 7 times as

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[304] Meiggs 1982, p. 154; Veal 2017, p. 330.

[305] Fortification wall: Zangger et al., 1997, pp. 606-613 and Davis & Bennett, 1997, p. 106; Chariots: PY Sa series in the Linear B documents.

[306] Malthi is a curious case, since the walls that ring the settlement are robust and enduring; they are constructed directly on the bedrock, which offers stability, and they are at least 2 m thick. What is confounding about their design is their height, which would have been easily scalable.

[307] Thucydides, *History of the Peloponnesian War,* 2.75.1-5.

much wood fuel in the LH period as it did in the MH period. At the rate of two tons per household per year, the woodcutter went from supplying 100 tons to 760 tons of raw wood per year, just to fuel the hearths.[308] While indeed the population estimates of the area are imprecise and, by virtue of their foundations in surface survey and pottery types, give the impression that populations are static then jump suddenly at each chronological division, they assist in roughly modeling domestic fuel demand across the periods in focus here. As such, we can approximate the variable costs to the area surrounding the Bay of Navarino: 50,000 tons in the LEMH and 380,000 tons in the Mycenaean period. To understand these figures, it is worthwhile to imagine this weight in terms of trees.[309] The total yearly wood consumed by a family must be understood as seasoned, dry wood, which is lighter, resistant to decay, and releases substantially less smoke than greenwood. During the process of seasoning, the moisture from the wood is lost, and as a result its weight is reduced by ~50%. If we approximate that one pine tree makes one ton of seasoned firewood.[310]

	2200 - 1700 BCE	1700 - 1200 BCE
Equivalent felled trees for this study region	50,000 trees	380,000 trees

Table 3.1 Total trees required to sustain the domestic fuel requirements of the PCA population for each 500 year period.

Heating and domestic energy needs have already overtaken timber, which is remarkable given the habit of zeroing in on the depredations of the farmer and the goat as the primary drivers of deforestation.[311] In fact further withdrawals fueled pyrotechnic industries and augmented this already impressive rate of extraction. Ceramic kilns, for example, supplied households with cooking, storage, and feasting vessels, and at the zenith of Mycenaean cultural and economic hegemony they served expanded usage as containers for exported products, such as perfumed oils, and single-use feasting paraphernalia. A parochial bent in pre-state Messenia brought fewer imported ceramic vessels than the succeeding period, and indeed between EH III and MH II pottery was markedly regional. As such, though indeed there is evidence for small-scale exchange, each community relied quite heavily on their own ceramic outputs.[312] As brittle pottery broke daily, additions and replacements would have kept the kiln fires stoked.

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[308] 2 tons/household/year is an oft cited datum, which comes from a casual survey of Greek families living in the Argolid in the 1970s (Forbes & Koster, 1976, p. 122).

[309] Other woody fuel sources would have also been available, especially deadfall, the byproducts of pruning, and clearing woody shrubs from fallowed or otherwise unused land.

[310] Average pinewood density is *dry*: 27 pounds per cubic foot; *green*: 37 pounds per cubic foot; given a typical 10 inch diameter that tapers toward the top (~75') and the weight of the branches, 1 ton per pine tree is a reasonable estimate.

[311] In favor of fuel use being more damaging than grazing: Wertime, 1983; Forbes & Koster, 1976; an analysis of the damage caused by forest pasture and the collection of forest litter: Gimmi et al., 2008.

[312] Rutter, 1993; Zerner, 1993.

In the LEMH (EH III - MH II), there were four well-established settlement loci that clustered around the coastal plain and Selas River: Iklaina, Pylos, Petrochori, and Korifasio:Beylerbey, while smaller farmsteads pepper the landscape between them, such as Deriziotis Aloni.[313] Unfortunately, physical evidence of kilns have not been recovered archaeologically, but the extant manufacturing data from Messenia suggests that pottery production was organized at a household level.[314] Contemporaneous analogues in Asine and Lerna suggest that there may have been five-eight local semi-specialized producers, who operated on a part-time basis.[315] Each producer may have had a small, possibly a pit fire or single chambered kiln, while the firing of larger vessels was accommodated by a communal, constructed kiln with a greater capacity.[316] Individual pit fires may also have served to produce coarseware vessels, which can withstand the dramatic temperature changes of the direct heat, while a communal, chambered kiln may have offered the temperature control necessary for firing delicate fineware vessels.Archaeological evidence for MH kilns indicates a propensity for paired kiln features that operated synchronously, as was the case at Plasi, Lerna, Makrygianni, and Kirrha.[317] Given the size and structural differences between them, each kiln may have served distinct objectives, perhaps dedicated to one particular fabric type of vessel size. The labor input of a semi-specialized, part-time potter is naturally limited by subsistence demands and the absence of supplemental labor in the form of apprentices, and as such firing episodes would have likely been intermittent. It may have taken several weeks to generate enough vessels to fill the firing chamber of a kiln, and time-sensitive agricultural practices, like sowing and harvesting, would have taken precedence in the fall and spring respectively. Moreover the winter rains would have perennially hampered ceramic production, since the atmospheric moisture makes it especially difficult to dry the vessels. With this in mind, we may place a very rough estimate of firings per year per kiln at 12 and the aggregate per year firings in the study area at 275-375.

Elsewhere on the Greek Mainland we see a transition beginning in the Early Mycenaean period wherein the number of independent potters and production centers contracts, and a skilled, full-time labor force ramps up both the quality and the quantity of their products. At Kirrha a new, much larger kiln was constructed in LH I, and at Plasi the larger kiln (kiln 1) was renovated and the stoking area was moved and enlarged.[318] At Lefkandi craft specialization began early, around MH II, and the experience and skill required in the superior clay levigation, wheel use, and temperature control as well as the greater homogenization of the assemblage and larger number of vessels in circulation suggests that dedicated, full-time craftsmen (with apprentices) supplied the community.[319] If starting in MH III this socio-economic shift took place in western Messenia that supported a specialized workforce and demanded more skillfully crafted ceramic products, then we can infer that fewer kilns undertook

[313] Stocker, 2003.
[314] Spencer, 2007, p. 194.
[315] These estimates are based on the unique fabric types and manufacturing styles at Asine, where, according to Spencer, around eight household industries supplied the population with pottery on a part-time basis (Spencer, 2007, pp. 155 and 204)
[316] Spencer, 2007, p.154; Day, 2004, pp. 105-142.
[317] Kapsali, 2019.
[318] Kapsali, 2019, p.46.
[319] Spencer, 2007, p.130.

exponentially more yearly firings. Direct evidence of such a transition in the study area does not exist, but proxies that index social and economic reorientations towards hierarchy and individual prestige are widespread in Messenia and beyond. Mortuary behaviors that underscore wealth and individualism, like the tholos tomb, and elaboration in every category of display. This move broke from the stability and stasis of the LEMH and fostered greater demand for fine manufactured objects. Blegen and Rawson note the "magnificent [Palace Style] jars" dated to the LH I and II at Kakavatos, Tragana, and in tholoi in the palace surrounds.[320] Higher *quality* in the early Mycenaean period and *quantity* in the later Mycenaean period are testimony to intensified production strategies.

To approximate the fuel burden of ceramic production in the early and high Mycenaean periods, it's prudent to assume industrial nucleation and specialization took place here. More specifically, nodes of pottery production became fewer while the labor inputs grew, as higher quantity and quality demanded a highly skilled and dedicated workforce. The Palace of Nestor may have had a designated ceramic workforce, evidenced by the small (ca. 1.5 m) kiln in the Belvedere area of the acropolis in use between LH I - LH IIIA.[321] Moreover, by the LH IIIB four professional potters supplied the palace, one of whom, *pi-ri-ta-wo*, was named as the "potter of the *wanax*" and likely furnished the palace with nearly half of its 3.5 metric tons of pottery (6,000 pots) stored in-house.[322] With this and the population growth in mind, we can approximate the number of firings per year at 1,500 - 1,800.

	Firings per year	Fuel volume (per year)	Total fuel volume (period)
		Equiv. trees	Equiv. trees
LEMH	275 - 375	68 - 94	~40,000
Mycenaean	1,500 - 1,800	375 - 450	~200,000

Table 3.2 Total trees required to sustain the ceramic production requirements in the PCA for each 500 year period, based on the estimated number of firings per year.

In an adjacent industrial sector, the creation of lime plaster in limekilns was a costly enterprise both in labor expenditures and in fuel resources. Early iterations of this material, applied to the walls of houses beginning in the Neolithic period, were naturally occurring calcareous mud plasters with low concentrations of lime. Evidence on the mainland for a preference for this wall treatment appears at the House of Tiles in Lerna, where a mud plaster and red wash appear.The transition into higher-lime, thermally-altered plasters appears first in the First Palace Period on Crete.[323] By LH II the mainland began to adopt the technology, which required the maintenance of 700-1000℃ temperatures for 48-96

[320] Blegen & Rawson, 1966, p. 352.
[321] Nelson, 2001, pp. 15 and 58-59.
[322] This attribution to *pi-ri-ta-wo* is based on the four primary fabric types found at the palace, one of which was used to make half of all the recovered vessels (Hruby, 2013, p.117).
[323] Jones & Photos-Jones, 2005.

hours to transform chipped limestone into relatively pure lime plaster.[324] The paucity of excavated settlements in Messenia make it difficult to estimate the region-wide ubiquity of lime plaster application on floor and wall surfaces. As such, we cannot know at what scale the lime production industry operated. In 19th c. CE Dhidhima, for example, nearly 50 limekilns were identified on the coast, situated such that lime plaster could be easily exported on shipping vessels. Most kilns were family operated; some families only undertook three or four firings per year, while others worked full-time and fired once a month. In either case, the fuel cost was exceptionally high, requiring roughly 100,000 kg (100 tons) of wood fuel *per firing*.[325] What is certain in the Late Helladic is that intensive lime plaster production took place at least episodically, supplying the workforce that wrought the Palace at Ano Englianos, possibly in LH I and certainly in LH II, LH IIIA, and LH IIIB.[326] At least in the last phase of construction, the structures belonging to the previous iterations of the palace were largely leveled, however plaster floors from the LH II phase have been recovered archaeologically, and the finely painted fresco walls of the later phases confirm the systematic manufacture of purified lime plaster for the sake of decoration and embellishment. During these bursts of construction activity, it may be fair to assume that limekilns were stoked year-round.

Up until this point, the fuel costs described have been quotidian; the forest resources serve the banal obligations of households at any scale, buttressing daily life by heating food, homes, and the kilns that produce the vessels that store and serve that very food. A hallmark of Pylian state operations, on the other hand, was the mass production and circulation of boiled unguents, wholly divorced from the daily human demands. Investments in this industry, which appear to have been the exclusive entitlement of the palace, were generators of capital (economic, social, political, cultural, symbolic). To whatever extent perfumed oil could be considered a daily necessity, the extant archaeological and documentary evidence is testament to the political ambitions at the fulcrum of the perfumed oil industry. The industry's every dimension was a product of palatial statecraft.[327] The aromatics and olive oil were collected and stored in enormous quantities, likely procured from all over Messenia, the production supply and the oil's ultimate dispatch was coordinated by palace scribes, and its international exchange was carried out within established trading systems. Domestically, perfumed oil was gifted to elites and deities, which served as ennoblements and affirmed relationships the the benefits of indebtedness.[328] Oil was also certainly dispatched abroad, as has been well documented archaeologically, and it can be assumed that the "Pylians were using their perfumed oil for trade as well as for local uses."[329] Securing foreign trade allowed Pylos to acquire necessities, luxuries, and even some of the very ingredients requisite in perfumed oil production.

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[324] First evidence of refined lime plaster is at the Menelaion in Laconia, however there is a strong archaeological bias that makes it imprudent to assume that this was the first or only application in the Early Mycenaean period.

[325] Forbes & Koster, 1976, p. 123.

[326] Nelson, 2001, pp.179-187.

[327] "The state is the culmination of a process of concentration of different species of capital: capital of physical force, or instruments of coercion (army, police), economic capital, cultural or (better) informational capital, and symbolic capital. It is this concentration as such which constitutes the state as the holder of a sort of meta-capital granting power over the other species of capital and over their holders" (Bourdieu, 1999, p. 57).

[328] Bennett, 1958.

[329] Shelmerdine, 1985, p. 153.

Much square footage was dedicated to olive oil storage at the palace, most of which nestled behind the throne room in massive pithoi. A total of 61 large pithoi and 11 jars were stored across 4 rooms and roughly 116 square meters (over 1,000 sqft).[330] Not only were there tablets found in these rooms that pertained to olive oil, but more that had once lived on the second story fell to the first during the final destruction, suggesting that much more square footage on the upper story was allocated to the production and distribution of scented oils. In PY Fr 1202, a tablet that fell into Room 47 from above, 100 quarts of sage-scented oil was being distributed to a goddess during the festival of New Wine. Indeed 50 tablets, distributed throughout the palace document oil-related transactions, namely those relating to the acquisition of olive oil and the distribution of perfumed oil. They mark the initial and final phases of the manufacturing process, and the conversion from raw materials to the finished goods presumably would have likewise taken place in-house. Evidence for this exists both in the volume of olive oil storage and in the document, found in an oil storage room records the unguent boiler, *e-u-me-de*, receiving 38 stirrup jars of olive oil from *ko-ka-ro* (11 stirrup jars were recovered from that very room). In the oil magazines a tablet promising 24 liters of sage-scented oil and 24 liters of rose-scented oil "for anointing" to the town of *ti-no* (where the unguent boiler holds property among other state-contracted craftsmen). This pronounced spatial relationship between the palace's olive oil stock and the records of unguent production and distribution reveals the function of the storage itself: unguent boiling.

Bearing in mind the difficulty in estimating, even roughly, the intended timetable for unguent manufacturing, we can at least model the energy costs for converting the presumed volume of stored olive oil into the value-added finished good.[331] With the aromatics (cyperus, sage, coriander, and rose) honey, water, and/or wine were added to the mixture and brought to a boil. Theophrastus loosely details the boiling procedure, which varies considerably depending on the recipe. To make myrrh-oil, for example, the myrrh is bruised and deposited in the oil, over which hot water is poured. Immediately the oil separates from the water and is isolated. To make megalaion, on the other hand, oil must be boiled for 10 days, only after which they will add the aromatics.[332] For a conservative fuel estimate, one can consider the minimum requisite energy costs to bring the amount of oil stored in the magazines at the palace to a boil, rather than maintaining those temperatures over any period of time. For olive oil to boil, it must reach the temperature of 298℃, which, with a specific heat of 2 j/g and a total volume of oil stored in the pithoi at 25,200 liters, requires roughly 859 kg of seasoned softwood, most of a metric ton.[333]

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[330] Room 23: 5.5 m x 3.9 m, 17 pithoi; Room 24: 5.8 m x 3.9 m, 16 pithoi; Room 27: 6.9 m x 5.8 m, 16 pithoi; Room 32: 6.7 m x 4.9 m, 12 pithoi and 11 jars (Blegen and Rawson 1966, pp. 132-139, 139-143, 146-149, and 156-160).

[331] The distribution calendar is much clearer than the manufacturing calendar. In many texts there are calendrical markers that align with festivals, such as the *pa-ki-ja-ni-jo-jo me-no* (the month of *Pakijanios*) and the *me-tu-wo ne-wo* (the festival of New Wine) (Bennett, 1958, pp. 27-32).

[332] Theophrastus, *de Odoribus*, 29-30.

[333] 61 pithoi with roughly 413 liter capacities, based on the archaeological evidence, would hold 25,193 liters or 23,177,560 g (920 grams per 1 liter of oil) of oil. To raise 1 g of oil 1℃ takes 2 joules of energy. If the temperature must rise from ~20℃ to 298℃, it takes 556 joules per gram. The total energy cost to so change the temperature is 12,886,723,360 j. The average seasoned softwood contains 15 MJ or 15 million joules.

The final fuel cost to be tallied is a surprisingly innocuous one: metallurgy. Though certainly metallurgical programs have shouldered the blame for spectacular fuel expenses and catastrophic forest loss, in my estimation this was not a prime driver in the observable ecological changes in the region. Yet certain staggering figures ring loudly in our ears; the copper industry in Cyprus burned 4-5 square miles (1,000 - 1,300 hectares) of forest annually, the preparation of one oxhide ingot requires the charcoal of 120 pine trees with a single shipload of ingots costing 24,000 trees, and more generally "Over the whole of the Mediterranean littoral one might find minimally 70-90 million tons of slag from antiquity representing the divestiture of at least 50-70 million acres of trees."[334] Unquestionably these values are correct and that unmanaged fuel extraction would be a profoundly corrosive instrument, however the smithing practices undertaken by prehistoric Messenians were so much farther down the metallurgical chaîne opératoire than those involved in refinement that the fuel costs would be negligible. Exploitable sources of copper, tin, gold, and silver are unknown in Messenia, and the metals that were smithed and circulated in the kingdom were almost certainly exogenous. As such, the fuel deployed to mine ore, pre-roast, and smelt would have been spared.

Not only were these refinement stages outsourced, but the smithing itself could be done on a campfire. The melting point of copper is high enough so as to only be achieved through the use of charcoal and a furnace (1350°C), yet for every gram of copper replaced with tin (in the alloy) a "sixfold degree of fuel conservation" is introduced. In other words, a 10:1 copper to tin alloy is six times easier to melt than pure copper.[335] It is no surprise then that tin alloys became increasingly preferred, even compared to another more efficient alloy: arsenical copper.[336] At Nichoria this trend is borne out; all of the copper samples whose composition was tested were tin alloys. High tin content was especially notable in the MH and LH III samples (43% and 42% containing 10% or more, respectively), with 90% of LH I-II samples composed of less than 10% tin.[337] This contraction of the tin content in the early Mycenaean period may reflect the throttling of valuable imported resources during a highly competitive episode in mainland state formation. In any case, the constitution of the bronze was, for most of the time, highly fuel efficient. It would have had a low melting point that, when subjected even to the flames of a campfire, made bronze casting mercifully low-tech and low-cost.[338] We can assume that the bronze composition at Nichoria would have been relatively consistent kingdom wide, especially during the MH and LH III. These values reveal early democratization of tin imports, with coastal cities opting in to the trading transactions, followed by a highly regulated system of palatial consignment. The Jn series is testament to the latter paradigm, wherein smiths are allotted typically 1-3 kg of bronze. Since indeed tin and copper ingots are circulated/traded separately, as we can see from the

[334] Wertime, 1983, p. 452.
[335] Kaufman & Scott, 2014.
[336] In the Levant, for example, between the end of the Early Bronze Age and the Middle Bronze Age objects made with tin alloys increased by 101-151%, while arsenical copper objects increased by only 32-49% (Kaufman & Scott, 2014).
[337] Shelmerdine, 1981, pp. 319-325.
[338] In reference to the house of a smithy at Nichoria, whose occupation was detectable by the slag, burnt patches, ash, and bronze scrap littering the floor, Shelmerdine states: "[t]echnology was adequate, but not highly sophisticated" (Shelmerdine, 1981, p. 323).

shipwreck evidence at Uluburun, and yet only one substance is distributed to Pylian smiths (*ka-ke-u* χαλκεύς), we must assume that the mixing was a preliminary and seemingly regulated operation.

Despite the grim outcomes, therefore, the quantification of fuel expenditures ought not be greatly altered by the high demand, especially in the Mycenaean period, for weapons of war and conspicuous display. A reasonable impact may be in the modeling of domestic fuel use. Perhaps a hearth fire was fed with hardwoods, burning longer or more consistently, in order to accomplish a smithing task. Perhaps a campfire was set earlier in the day than otherwise necessary. Expanding the life or quality of fires that already burned in the rhythms of daily life may have been all that was necessary to craft these valued implements. As such, the range of yearly domestic fuel consumption may be justifiably pushed to its upper extreme, two tons per household.

3.3 Conclusion

The exploitation of wood sources is a predictable human endeavor, and even its *over*exploitation is a logical outcome of population growth. Modeling diachronic demand for timber and fuel has illustrated an approximate profile of the human burden on the forests that once shaded and sheltered the prehistoric populations who settled around the margins of the Navarino Bay. In pre-state conditions, scattered communities both on the coastal plains and steep ridges at the foot of Aegeleon grew without embellishment; monumentality was perhaps reserved for earthenworks, and centralized loci of power girded with great timbers and adorned with painted plaster were the products of later statecraft. A general orientation toward the coast made watercraft, especially in the protected bay, a strong likelihood, but there is no evidence for long overseas journeys with large vessels and cargoes, and for the majority of the LEMH the wind power that made such ventures feasible had yet to be harnessed. Pronounced regionalism and small-scale trade characterized the specialized craft market, and while pottery and metals circulated in small volumes, it was ultimately the hearths, as few as they were, that asked the most from forest resources (ca. 50,000 trees over 500 years).

A paradigm shift toward individual status and ostentation that began in MH III buoyed secondary products economies, more abundant trading relationships, and monumental architecture. Towering ashlar walls and thick oak beams, built and rebuilt over generations, framed the burgeoning political nuclei and withdrew from the most valuable timber stock at scale, 400-500 large oak trees per iteration of each monumental building. Thick white plaster elaborated with finely wrought painted frescoes made lime plaster a material of great political value and justified the use of 100 tons of fuel (equivalent to 100 pine trees) per firing. Naval and trading vessels needed upkeep and replacement, which led to the felling of 15,500 pine trees and over 1,300 oaks over the course of the Mycenaean period. The products of craft specialization and market dependencies (fine finished goods) reinforced preferred modes of display and operated as markers of heterogeneous status. To supply ceramic markets, highly skilled artisans stoked near continuous kiln fires, fed by the 200,000 trees felled for fuel. The commodification of perfumed oil brought tens of thousands of liters of olive oil into palace storage, all of which underwent boiling and elaboration. Finally, scatters of smaller hamlets and homesteads grew in residents and in acreage, the daily needs of which being supported by the 380,000 trees used for domestic firewood. In sum, the social and political changes that are inscribed clearly in

the archaeological record–the tholoi, fine crafts, export economy, and monumental state/palatial architecture that served to concentrate and circumscribe wealth and power–wrested more from the forest than the previous period by a factor of 10.

As was examined in the previous chapter, though, these costs exert uneven pressure across tree species. Pine population plummeted at the beginning of this social transition and never recovered, yet healthy populations of deciduous oaks seem to have persisted through the Mycenaean climax. Demand does not account for this asymmetrical outcome. In fact, in monumental architecture and pyrotechnic and domestic fires oak is often preferable. As fuel it not only has one of the highest calorific potentials, but it also sustains longer, more fuel-efficient fires with even temperatures, which are especially helpful in kiln or furnace contexts where sustained temperatures enable the desired chemical changes to clay, metal, or limestone.[339] The smoke it produces is also much milder than that from conifers, which contain a high sap content and generate acrid smoke that is highly irritating to humans in confined spaces. In architecture, particularly monumental architecture, oak timber provides large, straight, and durable beams that can bear the weight of heavy roofs, walls, and multiple stories. The pine, therefore, absorbed the costs of growing populations despite its overall inferiority, while deciduous oak was subject to different practices and as such was spared from the scale or style of extraction that eliminated pine stocks. Moreover, this continued to be true even *after* the pine was depleted to the extent where it could not shelter the blow. Few other deciduous species sustained populations large enough to substitute oak's fine hardwood. Plane trees, walnut, and judas trees were simply not abundant enough at any stage under study here, and olive and pistacia (*lentiscus* and *terebinthus*) were scarcer and provided inferior timber and fuel. And yet, oak is abundant in the archaeological record; it is the primary organic building material in the final phase of the palace at Ano Englianos and the CTB at Iklaina.

For the demand modeled above to accord with the environmental data, two things must have been true. First, oak-specific practices must have curtailed extreme overuse prior to and following the loss of pine resources. This most likely included coppicing, restricted felling, limited access, and oak fuel acquisition may have been exclusive to fallen deadwood. Were these rules not in place, then we would see parallel, if staggered, deforestation outcomes in the pollen data. Where we tend to see the oak employed en masse must have been privileged usages, either because it had always been its intended use for which it had been reserved, or because those commissioning its use in monumental architecture were in a position to override the inherited (conservative) conventions of use practice. Second, alternative fuel and timber sources must have been sought and ubiquitously applied.

The construction of the LH IIIB palace affirms these presumed adaptations. In fact, we can see at the Palace of Nestor that the final construction phase employed a special kind of architecture that *saved* wood. In previous iterations of the palace, as well as other large scale construction projects elsewhere, large horizontal oak beams stabilized ashlar and rubble walls and offered internal support. In the final phase at Pylos, however, the builders changed their style such that they *removed* and *reused* wooden supports. In what is called a "pier-wall" system, they framed each section of the wall until the rubble-mortar hardened, then removed the framing and filled the spaces where the wood once stood

[339] Marston, 2009; Wright, 2018; Veal 2012.

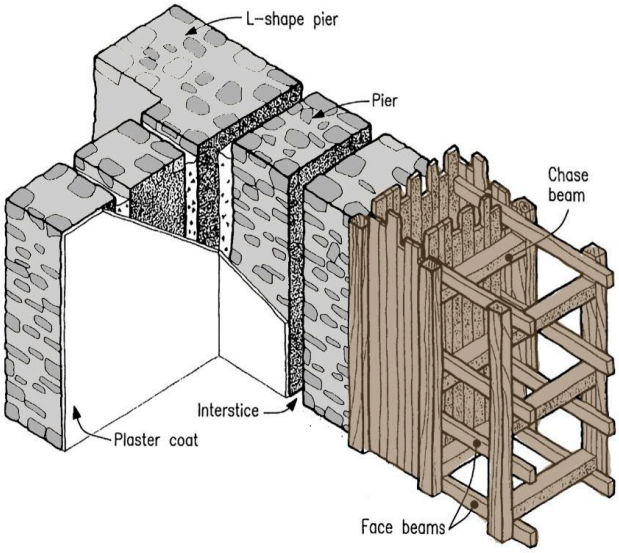


Figure 3.12 Reconstruction of the pier-wall construction method (Nelson, 2001, fig. 84; colorized by author).

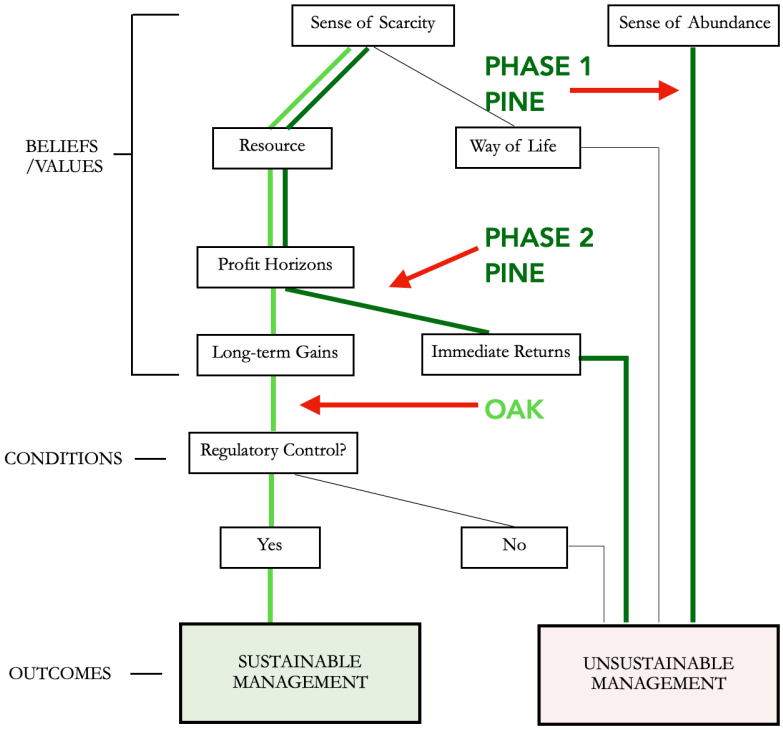
with plaster mortar, allowing them to recycle the framing for each subsequent section.[340] Consequently, the walls of the later palace were incredibly sturdy while sparing the large longitudinal beams and chases typical of the *xylodesia* system. Since the wood for the framing was temporary, lower quality construction material, like olive or conifer wood, could be used in lieu of the much more durable oak wood. The "pier-wall" method was atypical on the mainland, and up until Michael Nelson's 2001 reassessment, it was assumed that the rubble piers were laced with now absent wooden supports. Prior to LH IIIB the timberless "pier-wall" technique appeared nowhere else in the Aegean, and Wright attributes its sudden appearance on the mainland to the "exchange of craftspersons" from Anatolia, where comparable techniques were applied.[341] In palatial architecture, where one would assume every resource would be used in order to serve monumentality, fine craftsmanship, and embellishments, they are *conserving* the readily available oak with novel technologies.

Demand for fuel was also likely met by secondary fuel sources, like dung fuel and olive pomace. The waste generated through olive oil pressing is particularly convenient, since large quantities are easily accumulated (400 kg per 1 ton of olives pressed) as a byproduct of large-scale industrial processing.[342] As early as the Early Bronze Age, producers of oil have gathered the olive skin, pulp, crushed pits, and seeds into cakes and sundried them, so as to remove the remaining water content (20-30%). The result is an exceptionally efficient fuel source, which has a 30% greater potential than raw hardwood.[343] Veal argues that olive pomace would have never overtaken wood fuel, due to its seasonality, however the long term storage of pomace cakes in water makes it viable for up to 6 months.[344] Beyond its availability, the burning properties of pomace make it highly desirable, especially as fuel for pyrotechnic industries that require consistent temperatures over long periods of time.[345] In fact, Rowan observed that modern potters in Messenia favor olive pomace over wood charcoal, due to its low ash volumes and efficiency.[346] Moreover, at Mochlos there is archaeobotanical evidence of olive

[340] Nelson, 2001, pp.154-168.
[341] Wright, 2006a, p. 33.
[342] Rowan, 2015, pp. 465-482.
[343] Veal, 2017b, pp. 390-391.
[344] Rowan, 2015, p. 466.
[345] Rowan, 2015, p. 467.
[346] Ibid.

pomace fuel in the neopalatial Minoan town, roughly synchronous with the olive tree boom in Messenia and indicative of contemporary use.[347] Given the surge in olive tree populations starting in 1500 and the abundance of evidence for palatial perfumed oil industries, this shift would have been easy enough and, most importantly, *preferred* over the extraction of oak wood at the same scale as pine extraction.

Based on the reconstruction of fuel and timber demand and the environmental outcomes, what, then, can be said about the beliefs and values of Pylians living around the Bay of Navarino? On the one hand, there is evidence for an outcome that likely followed the sustainability pathway on the left side of the flow chart. There was a sense amongst the population and/or the governing body of *resource* scarcity that was resistant to the needs and desires for immediate returns, even when the supply of pine was down and demand for timber and fuel was high. Likewise, those who held these beliefs *also* had regulatory control, such that use-practices directly reflected these beliefs and values.



Somewhat ambiguously, however, a *moral forest* and a sustainably managed *crop forest* can have similar outcomes. How, then, can we distinguish them? In my estimation it is the *combination* of outcomes that speaks to a bifurcated management scheme; practices that protect tree populations from over exploitation were applied to some but not all ecosystems. Engagement with oak could be controlled *because* the pine (and later olive pomace) could supply the needs of the population and manufacturing enterprises. The nature of oak versus pine regeneration is also revealing, since deciduous oak is delicate and difficult to establish when threatened by grazing. Were grazing *not* sequestered, then the deciduous oak shoots would have been readily consumed and would never have formed stable, flourishing populations. Conversely, the pine typically grows quickly and is more resilient to environmental threats. The fact that its populations did not recover means that it was likely subject to heavy grazing or other tacit or intentional modes of suppression.

The aggregate picture is one of a moral forest, where independent actions and choices of individuals directly affect collective gain, and the reinforcement of propriety is facilitated by social

[347] Margaritis et al., 2022.

norms and codes of behavior or explicit rules, which limit the field of choices an individual is willing to make. Conversely, there is an unsustainably managed crop forest, which, without regulation, was over exploited by those who wished to protect their way of life and/or those who are interested in immediate returns, despite the waning wood supply. One may call to mind the sacred groves in the Greek historical period, which were subject to specific regulations that protected their integrity via divine associations. In the Bronze Age, despite increased oak timber and fuel demand, these populations were set apart from the common-pool. In this context, we need not distinguish between "sacred" and "private," since regardless of the proprietor, be they divine, royal, or bureaucratic, it appears access rights were granted to those in service of the state.

Two facets of the bifurcated system testify to social–rather than state–enforcement. First, according to the fossil pollen record, the moment at which the pine and oak paths diverge, ca. 1700 BCE, is so early in the state formation process that the assumption of total command over resource use in a large, highly populated region of what would later become the Pylian kingdom strains credulity. While certainly the pine trajectory reflects early changes in the social and economic landscape, there is little evidence to support large-scale, top-down regulatory directives. Second, the palace appears to have outsourced fuel acquisition responsibilities–and, in a sense, scarcity anxieties–to the contracted craftspeople. In other words, despite the meticulous record keeping relating to the perfumed oil industry, there are no instances in which fuel is quantified, recorded, distributed, collected, or at all mentioned. This is not a simple sample bias, which is often the case in an intentionally temporary corpus that was only incidentally burned, since early and late manufacturing stages appear in the documents with the noted absence of the intermediate, fuel-dependent heating phase. Thus, all timber and fuel acquisition strategies were tacitly condoned by the state, in as much as they were extraneous to their specific oversight. The pressure to procure in compliance with the above stated rules, therefore, must have been community generated as well as community enforced.

Behaviors at the top of the hierarchy, however, both accord with and depart from these longstanding institutions. At once the palace employed wood-saving construction techniques that *specifically* spared large volumes of oak timber in LH IIIB, yet the monumental palace *still* perched atop oak columns, reinforced by oak joists, and was sheltered by oak roofing timber. Moreover, whereas the administrative interest in woodcutters is wholly absent in contexts of industrial fuel use, it is noted when oak must be delivered to chariot manufacturers. In the document PY Vn 10, woodcutters (*du-ru-to-mo*)–or *oak*-cutters– were recorded as "giving"to the chariot workshop fifty *e-pi-phu-ta* (ἐπὶ φύτα), which has been suggested to mean "sapling" as it relates to ἐπιφύομαι "to grow upon." The bending of wood to create chariot wheels almost certainly relies on green oakwood, since the straight grain and coarse texture make it the choice bending material. In light of this I might rather suggest "branch" or "bough" as a translation for *e-pi-phu-ta*, which maintains the etymology of the translation but whose valence is more harmonious with sustainable appropriation practices.

PY Vn 10

1. o-di-do-si , du-ru-to-mo ,
   The woodcutters give

2. a-mo-te-jo-na-de , e-pi-[•]-ta 50
   to the chariot workshop, "saplings" 50

3. a-ko-so-ne-qẹ 50
   and wood[348] 50

4. to-sa-de , ro-u-si-jo , a-ko-ro , a-ko-so-ne
   and the land of Lousos [give] wood

5. 100 , to-sa-de , e-pi-[•]-ta 100
   100 (?) and so many "saplings" 100

Despite their established apathy–at least in their records–toward fuel appropriation, the palace here makes note of what is almost certainly oakwood procurement at Lousos, a nearby coastal settlement. Special notation of woodcutters is entirely unique in the Linear B corpus, and presumably it is their intersection with chariot-making that elevates them to the orbit of administrative oversight in this case. This document can be read in several ways: either the palace is itself accounting for its own use of protected wood stock, or it is enforcing the accountability of the woodcutters in Lousos. In other words, the palace is either overriding conventional conservative use practices with deference paid to the community of users via careful accounting and internal oversight, or the Lousian woodcutters are procuring *state* regulated oakwood and as such they are carefully accounted for in the documents.[349]

With the evidence at hand it is difficult to discern this subtle difference. While indeed the institutions of oak conservation seem to have been the result of community consensus 500 years before these documents were written, it is unclear whether or not the palace appropriated the institutions to serve its own interests. The management practices of common-pool forest resources and the beliefs, values, and institutions that governed them were coded in the landscape. The rules that protected the oak trees were coercive enough, or adhered to so diligently, that the degradation of the pine had no effect on them. Rather than change the rules, the Messenians changed, at the very least, their fuel sources, while the palace either *violated* appropriation rules in order to construct a palace, a navy, and

[348] Ventris and Chadwick translate this as "axles" from ἄξων, however the context, which has woodcutters delivering unfinished, raw material to a workshop, makes this translation logically inferior. I have provided "wood" as a more intuitive translation, based on Hesychius' definition of ἄξος as a synonym for ὕλη "wood, matter," according to Macedonius.

[349] More careful accounting of what is most likely oak timber appears on PY Vn 46, which, by standard interpretation, lists construction materials for the megaron. Interpretation of this list is confounded by the fact that each entry is, for the most part, a string of hapaxes and that they lack a clarifying ideogram. There is agreement that the etymology of the listed items belong to the "semantic sphere of woodworking and carpentry" (Palaima, 1991, p. 298), and the conventional reading includes various quantities of cross-beams, roof-beams, columns, pillars, fittings for insertion of walls, and door posts, all of which must have been oak within the context of the monumental palace from a structural as well as archaeological perspective (as discussed above). Unlike Vn 10, however, the source of these timbers is not specified in the extant documentation, since the listed items are finished/differentiated and thus originating from a workshop by the time they were counted here (Palaima, 1991).

war technologies, or took advantage of the established institutions and assumed control over their enforcement so that they could engage freely in costly statecraft. With this in mind, I now shift focus to the second common-pool resource under study in this project–arable land–and investigate whether similar social structures governed choices pertaining to sharing and resource longevity, and whether state involvement affected them.

4. PRIVATIZATION AND THE ECONOMICS OF LAND TENURE

A parallel move toward privatizing key resources is observable in the administrative records, written in Greek with the Linear B script ca. 1200 BCE, dedicated to transactions related to private and communal landholdings. In both strata, the privatization of arable land/oak resources both accommodated the threat of scarcity under conditions of exponential demographic growth and consolidated sources of social and economic capital. Here, private land parcels were constructed to sustain a growing population under the highly extractive conditions of palatial hegemony and would have coexisted with the traditional communal land arrangements. Property held by private individuals was set apart from the common-pool and, I argue, became subject to tenure-bound service requirements in the form of coerced redistribution.

4.1 **An Introduction to the PY E-series**

The bulk of the Linear B documents from Pylos were first discovered by Carl Blegen in 1939 in an area of the palace that appears to have been an archive room, or archive complex near the entrance.[350] Here, scribes collected data about palatial and provincial economics, the movements of goods in and out of the palace, on clay tablets. These tablets had several forms; smaller "leaf" tablets housed single entries, possibly information collected in the field as commodities were counted. Collections of single entries were subsequently grouped and rewritten on larger clay tablets called "page" tablets. A lot can be gleaned from the process of re-inscription, especially as changes in language and word order reveal important aspects of their administrative organization. Despite this careful recording method, none of the tablets, even the page tablets, were meant to be permanent, and the clay was likely reused at a given interval (monthly? seasonally? yearly?). Their survival was an accident of history, as the fiery destruction of the palace ca. 1200 BCE incidentally baked the clay, allowing them to survive for millennia.

While its location is unknown, the settlement called *pakijane* (*pa-ki-ja-ne* (pl.), *pa-ki-ja-na* (sg.); likely from Σφαγιᾶνες/α "the place of slaughter")[351] provides the primary setting for the surviving tablets related to land at Pylos. This is one of the nine towns belonging to the Hither province and is always listed fourth in the fixed order, prompting many to suggest it existed very close to the administrative center at the Palace of Nestor: Pylos.[352] Not only does the name of the town and the volume of cult personnel registered on the documents suggest it was an important religious center, but the Fr-series also records a number of offerings (figs, grain, oil) being sent to *pakijane* and to Potnia at *pakijane*, who was likely the deity worshiped at the sanctuary there.[353] This place was also the site of a

[350] See Chapters 1-3 of Ventris and Chadwick (1953) for more information about the discovery, decipherment, and script.
[351] The root *σφαγ-* appears in Classical Greek in words that express the idea of slaughter, sacrifice, and religious offering. Lupack 2008 directs our attention to *σφάζω* and *σφάγιάζομαι* "to slay a victim, to sacrifice," *σφάγιον* "victim, offering," *σφαγίς* "sacrificial knife," and *σφαγεῖον*, a bowl used for catching the blood of the sacrificial victim.
[352] See Section 2.2 *The Geographical Scope of This Study: the outline of Pylian control in Messenia* for a more detailed discussion of the Hither and Further provinces and the fixed list of towns that constitute them.
[353] Lupack, 2008, p. 46; Fr. 1209.1, Fr 1216.1, Fr 1217.3, Fr 1224, Fr 1233.1, Fr 1236.1.

settlement, possibly home to 40+ family units. Lupack, however, posits that the sanctuary pre-existed the town, which subsequently developed around it.

The importance of *pakijane* to the palatial center, affirmed by its position as first on the list of gifts sent to various deities on Tn 316 and the fact that it was the site of the *wanax*'s initiation,[354] has been marshaled as evidence for their physical proximity. In fact, in the left margin of Tn 316 the word *pu-ro* "pylos" was written with syllabograms so large that they take up two lines, making all of the adjoining entries appear to notionally belong to the spatial sphere of Pylos. Such proximity would have allowed for processions between the palace and the sanctuary at *pakijane* to take place, linking the state's administration and personnel with an extra-urban sanctuary at the frontier of the territory and symbolically articulating a bounded whole.[355] A scene such as this was depicted in the vestibule of the Megaron at the Palace of Nestor in Pylos, in which a procession of individuals carrying offerings toward an altar flanks a large bull (see Figure 4.1). Bennett, Chadwick, and Lupack agree that *pakijane* was probably situated in/near the modern town of Hora,[356] 3 km northeast of the palatial center, based on its extensive chamber tomb cemetery with LH I and LH III pottery, called Volimidia.[357] In addition to being close to the palace and having the appearance of an important habitation site, Volimidia also belongs, fortuitously, to the pollen catchment area whose vegetation history was reconstructed in Chapter 3, making the farming and land tenure practices germane to the environmental reconstruction, and vice versa.

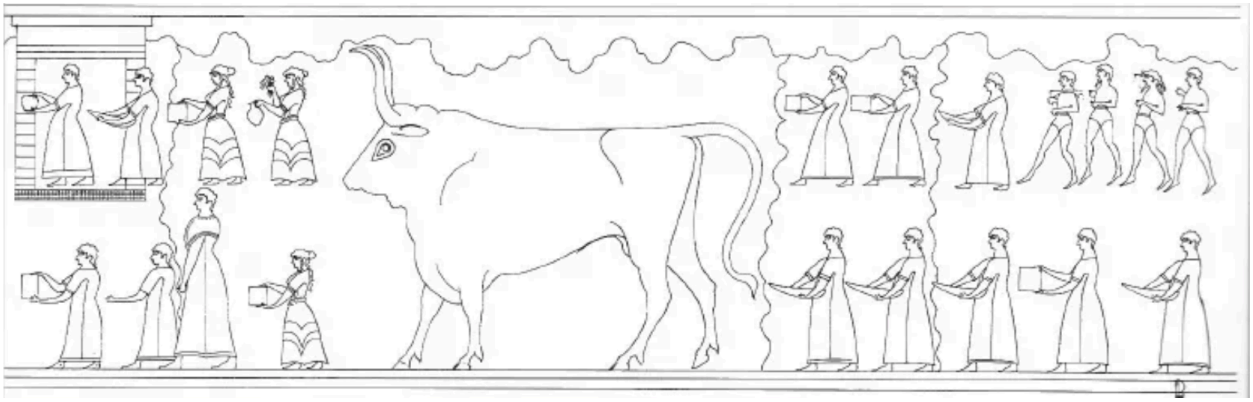


Figure 4.1 Drawing of the procession fresco from Pylos palace, Room 5 (Lang, 2015, pl. 119 top).

The Ea-Series, a group of 62 leaf tablets each consisting of a single entry, serves as an exception to the *pakijane* attribution. All of these documents were composed by a scribe separate from the one

[354] The document Un 2 lists assorted meats, olives, grains, wine, and other foodstuffs sent to *pakijane* (*pa-ki-ja-si* being the locative of *pa-ki-ja-ne*) for the *mu-jo-me-no* (possibly "initiation" from μυίω/μυέω) for the *wanax* (*e-pi wa-na-ka-te*) (Lupack, 2008, p. 47-8).

[355] vis-à-vis De Polignac's identification of the two poles, the urban and extra-urban sanctuary, that are bound by ritual pompe and serve to define the edges of society and the boundaries of ownership and belonging. De Polignac's focus is on the EIA, however it serves as an interesting analog for a seemingly comparable practice during the Late Bronze Age; De Polignac, 1995.

[356] Χώρα; alternative spelling: Chora

[357] Lupack, 2008; Bennet, 1999; Chadwick, 1976.

who generated the *pakijane* land documents (the Eb and Eo series, which later were collated into the En and Ep series). The formula is consistent with the rest of the land documents, indicating that many of the same institutions existed, however the name *pakijane* is never mentioned, and the occupations of the individuals listed cluster around pastoral work and craft production.[358] It has been suggested that the location recorded in these documents is close to both *pakijane* and to Pylos and that it was called *ti-no* in Linear B, based on an association with this location and three of the individuals listed in the Ea series: *ke-re-te-u* and *du-ni-jo*.[359]

The mechanics of the Pylian land administration system are encoded in the E-series Linear B documents, which are jargon-laden but relatively formulaic. The key to the conventional interpretation and classificatory scheme of this series is the meaning of the unit of measurement: the wheat ideogram □[360] and numbers of units tabulated in the dry measure standard.[361] This may not immediately strike the reader as being explicitly related to land; however, two interpretive calculations have been made and widely adopted. First, the application of the wheat ideogram is understood as metonymy, a representative shorthand for seeds more generally, likewise glossed on many tablet entries as *pe-mo* (σπέρμα). It would be imprudent and anachronistic to assume that the Pylians were engaged in wheat monocropping given the necessity of crop rotation, the difficulty in isolating a single species, and the precipitation patterns that favor hardier cereals, like barley. Second, the quantification of "seeds" would naturally be accommodated by dry measurement units, taken to reflect the amount of seeds required to sow an agricultural plot. The volume of seeds required to plant a field thus signified the field's overall dimensions/total area. This logical leap is not unprecedented; Ventris and Chadwick cite the Nuzi texts that use the Babylonian term for "donkey-load" to measure fields and the Sumerian system, which likewise uses seed volumes for land measurement.[362] Even in 19th and 20th century Greece, prior to the adoption of mechanized farming practices, fields have at times been measured in seed volumes, lending some credence to this particular reading.[363]

There are two important caveats to the mobilization of these analogues. First, the amount of seed applied to a field is highly variable from crop to crop and even from wheat species to wheat species. Broad beans, bread wheat, and spelt must be applied densely, while chickpeas and einkorn wheat must be distributed sparsely. Some farmers prefer to distribute all seeds densely in order to prevent the growth of weeds in their field, which sap the soil's nutrients and crowd the crops, while others choose to invest more labor in weeding in order to make each shoot successful.[364] In other words, seed volumes are inherently non-standard and, in a community that benefits from diverse yields, a meaningless mode of standard measurement. The second caveat is that it was *most* common,

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[358] see section 4.1.1a *Ke-ke-me-na* for a more detailed discussion about this formula.

[359] *Ke-re-te-u* is called *ke-re-te-u-**ti-no*** in PY Na 565, and *du-ni-jo* is described as *du-ni-jo **ti-ni-ja-ta*** (an adjective expressing that he is "from *ti-no*") on Fn 79.3; Lejeune, 1974; Lupack, 2015; Nakassis, 2013; Nikoloudis, 2012.

[360] This ideogram has been alternatively translated as "barley" by Carratelli, however Furumark and Ventris and Chadwick read "wheat," attributing the ideogram □ to "barley." This reading has now been widely adopted.

[361] For a more detailed discussion of the Mycenaean measurement conventions see: Hooker, 1980, p. 44 and Ventris & Chadwick, 1973, pp. 58-60.

[362] Ventris & Chadwick, 1973, p. 236.

[363] Halstead, 2014, p. 21.

[364] Halstead, 2014, p. 28-29.

prior to the adoption of the standard "hectare," for farmers in Greece to measure their plots in στρέμματα, or "turnings." This is a metonym for the "notional area that could be plowed in a day," which measured between 0.09 and 0.16 ha.[365] This standard of ox-days is echoed in the Roman unit *iugerum* "of the yoke," which measured 0.25 ha, and the Turkish *dönüm* "turning."[366] The English acre, while meaning "field" from the PIE root **agro-*, is a land measurement determined by the theoretical area a yoke of oxen can plow in a day, 0.4 ha. In places like Messenia, where short rising fields, frequent large boulders and stones, and undulating, irregular terraces are typical, any measurement at all is difficult and reluctantly estimated.

In light of these and other inconsistencies that I will discuss in more detail in section 4.2 *Inherited Interpretations and the Problems with the Leasing Paradigm*, the assumption that land was measured by wheat seed volume is somewhat unconvincing. Just as volumes of grain are doled out for rations, measured in the *do-so-mo* taxation tablets, and offered to sanctuaries/gods, I read these documents straightforwardly, as measurements of *produce*, not land. Yet the link between the E-Series and land distribution still exists: the ubiquitous use of the term *ko-to-na*, alternatively spelled *ko-to-i-na* in the Knossos tablets. This term is read as "plot" or "field" in the context of the Linear B documents and connected with the later Greek κτοίνα, which was used on Rhodes to refer to a socio-spatial unit comparable to the Attic "deme" and is glossed by Hesychius as a "subdivided deme."[367] In this series it is the κτοίναι and their allocations and distributions that are objects of palatial concern.

4.1.1 *Decoding the Formula*

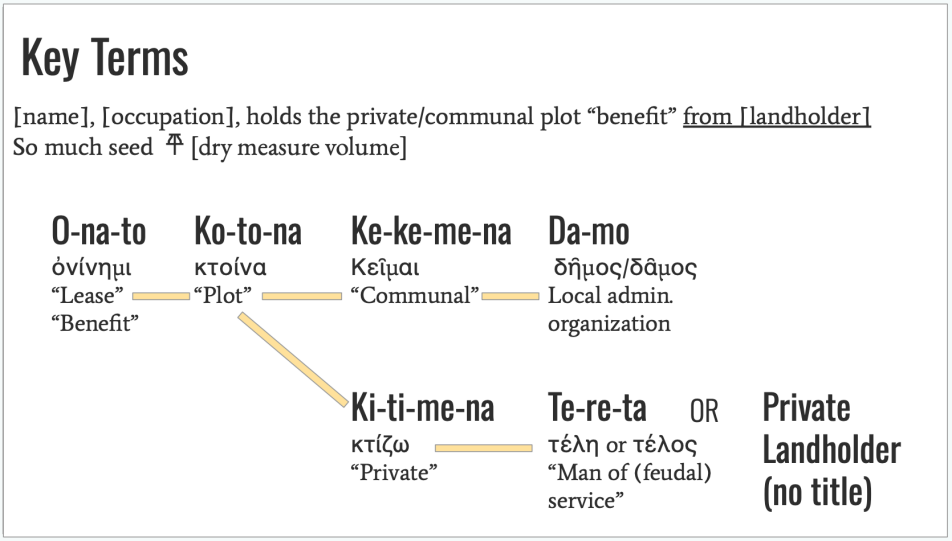


Figure 4.2 Standard formula and key terms flowchart with 1) term as rendered in Linear B, 2) historical Greek word to which the term is etymologically connected, and 3) its accepted meaning within the context of the documents. Flowchart shows relationships between terms.

[365] Halstead, 2014, p. 33.
[366] 1000 m x 10 m; Halstead, 2014, pp. 33-34.
[367] Hesychius of Alexandria, a Greek grammarian who lived in the 5th or 6th c. CE, used the Greek terms δῆμος μεμερισμένος; Ventris & Chadwick, 1973, p. 232.

The two varieties of κτοίνα of the Pylian kingdom were distinguished from one another in the records with the use of the participial modifier *ke-ke-me-na,* or *ki-ti-me-na*, each term designating a suite of implied, mutually exclusive attributes. I will go through each of these categories of land in turn.

4.1.1a *Ke-ke-me-na*

Most of the land documents from Pylos describe the land as *ke-ke-me-na*; the record is composed of seven large page tablets (Ep series) collated from 74 individual leaf tablets (Ea and Eb series). The entries belonging to the *ke-ke-me-na* land category register 301 individuals who hold the benefit – *o-na-to* – of the land from the *damos*. Damos, here, is understood as a version of δῆμος in Attic Greek and δᾶμος in Doric Greek, meaning the "people of the country, the commons" in the historical period and "a country-district, country, land" in Homer, its sense deriving from its root *$*deh_2$-, meaning "to part, divide."[368] The connection between *ke-ke-me-na* type land and the acquisition of a benefit sourced from the damos is the defining quality of this set. In almost every case, the qualifier *ke-ke-me-na* is paired with the phrase *pa-ro da-mo* "from the damos."[369] In certain instances the length restrictions of the line entry preclude the inclusion of the *pa-ro da-mo* element, such as in Ep 613, or the phrase is omitted altogether, such as in Eb 1440, yet the omission was tolerated by the scribes because the implication of *ke-ke-me-na* land being "from the damos" was assumed. Dunkel refuses this lexical coupling, arguing that the omission of the *pa-ro da-mo* element makes the pairing conditional and therefore tangential to the functional meaning of *ke-ke-me-na.*[370] Lupack, however, parses these anomalous documents and successfully argues that it is *because* of the consistent correspondence between the elements that the omission in a crowded line can occur on rare occasions.[371]

If we take this correspondence as essential to the meaning of *ke-ke-me-na*, then it aids in the narrowing of the etymological options. The sense is that the *ke-ke-me-na* land belongs to, or is administered by, the town/local population, divided from the landscape as a collective asset. The likely reduplication of the first syllable and the *-me-na* ending suggest that the word is a past middle/passive participle, and Ventris and Chadwick offer κεῖμαι "to be laid, to lie, to lie outstretched, to be situated" as the verb modified.[372] Alternate suggestions include the stem of the Homeric γέντο "seized,"[373] a derivative of the Indo-European **ghe* expressed in Classical Greek in words such as χῆτος "widow; lack, want," or a word sharing the root **kes* with Classical Greek κεάζω "split, divide, distribute."[374] The

[368] LSJ; Palaima, 2000.

[369] Uchitel makes an important contribution with respect to the *pa-ro X* phrase, suggesting that the force of the preposition πάρο + ablative has the force "at the disposal of" or "under the control of," rather than "from." (Uchitel, 1998, p. 148).

[370] Dunkel, 1981.

[371] In Ep 704.1, the crowding of the line is so severe, that even *ko-to-na* is omitted, meaning the implications of the term *ke-ke-me-na* are so intuitive, that the inconsistency is palatable; Lupack, 2008, pp. 58-59.

[372] LSJ; Ventris & Chadwick, 1973, p. 233.

[373] Ventris & Chadwick, 1973, p. 233.

[374] Lupack, 2008, p. 57 engaging with Aura Jorro in Aura Jorro, 1985; Palmer also makes a convincing argument that κεάζω replaced an earlier for of the verb "to split" that has been retained in the Homeric κείων and supported this reading with

immediate productive potential of the land is captured in the standard formula, which records each individual who received its benefits. This reading, therefore, does not accord with the sense of "want" or "lack," interpreted by many as conveying that the fields are fallow.[375] The sense of having been seized, communicated in the affiliation with the Homeric γέντο, is likewise discordant with the implications of damos control, which connotes commonly held, inherited property rights, unless the land in question has been conceptually seized from the wilderness under conditions of cultivation. More likely, however, is the suggestion that this land, cultivated and administered by the people of *pakijane*, is identified as "laid out," since in a sense this qualifier engages more tangibly with the practices of agriculture. Laying out one's field may have meant tilling, clearing of bush, or marking out the boundaries and edges. Κεῖμαι can also have the valence of something being set up/ordained,[376] goods or property being stored up,[377] or of continuing conditions, remaining.[378] It is easy to imagine conditions under which each definition could be applicable: the land was set up as belonging to the community or established as the territory that sustains *pakijane* and *ti-no*, it is the *surplus* stored up from the community's land, or, despite a trend toward privatization and individual allotments, it is the land that remains common. Despite the many and varied options for the etymological meaning of the term, its *functional* meaning seems clear: *ke-ke-me-na* plots were commonly held within the communities of *pakijane/ti-no* and administered by the damos.[379]

The standard formula for *ke-ke-me-na* type land dictates that each line entry begins with the name of an individual who received the benefit from the damos as well as, in many cases, their occupation. Below is a transliteration and translation of a few lines of a page tablet from the Ep-series, turned on its side so as to express every element that belongs in each line entry without omission.

PY Ep 212

re-ka te-o-jo do-e-ra o-na-to e-ke ke-ke-me-na ko-to-na pa-ro da-mọ ṭọ-so pe-mo □ T 6

[name], δούλη τεοῖο, ὄνατον ἔχει κεκειμενα κτοίνα παρό δαμῳ, τόσος σπέρμα: 72 liters

[name], (female) servant of the god, holds a communal plot "benefit" from the damos, so much seed: 72 liters

e-ri-ko-wo te-o-jo do-e-ro o-na-ṭọ e-ke ke-ke-me-na ko-to-na pa-ro da-mo to-so pe-mo □ V 3

[name], δούλος τεοῖο, ὄνατον ἔχει κεκειμενα κτοίνα παρό δαμῳ, τόσος σπέρμα: 6 liters

[name], (male) servant of the god, holds a communal plot "benefit" from the damos, so much seed: 6 liters

e-ko-to te-o-jo do-e-ro o-na-to⌞ ⌟e-ke ke-ke-me-na ko-to-na ko-na pa-ro da-mo to-so pe-mo □ T 1 V 3

[name], δούλος τεοῖο, ὄνατον ἔχει κεκειμενα κτοίνα παρό δαμῳ, τόσος σπέρμα: 18 liters

[name], (male) servant of the god, holds a communal plot "benefit" from the damos, so much seed: 18 liters

+7 more line entries

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analogous land-tenure terms that relate to "cutting" or "splitting" (Palmer, 1963, pp. 187-188 and Lejeune, 1972, pp. 137-154). See Lupack (2008, p. 57) for more discussion on the merits of each option.

[375] Caratelli, 1954; Duhoux, 1976; Dunkel, 1981.

[376] "ἄεθλα κεῖτ' ἐν ἀγῶνι" Il.23.273

[377] "δόμοις ἐν κτήματα κεῖται" Il.9.382; "πολλὰ δ' ἐν ἀφνειοῦ πατρὸς κειμήλια κ." Il.6.47; βασιλῆϊ δὲ κεῖται ἄγαλμα *is reserved* . . , Il.4.144.

[378] εὔστομα κείσθω *remain* unspoken, Hdt.2.171; νεῖκος ἔκειτό τισι there *was* an *enduring* feud, S.OT491 (lyr.)

[379] Brown, 1956; Foster, 1977; Furumark, 1954, pp. 52, 18-60; Hooker, 1980; Lupack, 2008; Palmer, 1954; Ventris & Chadwick, 1973.

The object of the main verb ἔχει "holds" in each entry is *o-na-to* ὠνατόν, which has been etymologically connected to the verb ὀνίνημι "bestow a benefit" in later Greek. In Book 16 of the *Odyssey*, Eumaeus speaks of how his master would have rewarded him for his hard work, if he had not perished in war: τῷ κέ με πόλλ' ὄνησεν ἄναξ, εἰ αὐτόθ' ἐγήρα (Od.XIV.67). In Book 24 of the *Iliad*, Achilles is compared to a a lion who ἄνδρας μέγα σίνεται ἠδ' ὀνίνησι without pity (Il. XXIV.45), and in Book 1, Thetis pleads with Zeus, asking that if ever σε μετ' ἀθανάτοισιν ὄνησα ἢ ἔπει ἢ ἔργῳ then he should grant her prayer. There are many other examples of this verb being deployed in situations where a reward, profit, aid, benefit, or delight are bestowed, and a loose translation of its noun form as "benefit" has thus been adopted in this discussion. There is, however, also a case to be made for an etymological relationship with the adjective ὠνητὸν "bought" (Doric: ὠνατόν) and the related verb ὠνέομαι "to purchase" and nominal form ὠνητής "buyer," the latter of which featured in the 4th c. BCE record of the 1% tax paid from the sale of land in Attica by various corporate groups, the *Rationes Centesimarum* stelae.[380] Ventris and Chadwick grappled with this option, but ultimately cited a Sanskrit comparandum that would suggest an initial w- would have been present in the Mycenaean Greek form of the word.[381] It is now generally accepted that ὀνίνημι is the closest correspondence.

This particular document has no header, and therefore likely belongs to a series of page tablets compiled such that they may be read together as one list. The accepted arrangement of these tablets is Ep 301, Ep 613, Ep705, **Ep 212**, Ep 539, and Ep 704; this example is thus situated fourth in the series and exclusively records the landholding arrangements of "servants of the god," a title likely assigned to cult personnel, rather than enslaved people.[382] In this standard order, Bennett (1983) posits a hierarchy, the top of which belongs to secular professionals, then secular and religious professionals, then purely religious professionals internally arranged hierarchically as well (priests, servants of the gods, other personnel). I am skeptical of this arrangement, since it is somewhat presumptuous to both assume an understanding of social hierarchy, particularly when faced with titles of unknown import (servant of the god, key-bearer, etc.), and to impose an artificial segregation between the secular and religious realms in the ancient Greek world.[383] Whatever the organizing principle, Ep 301 must be the first of the set, since it contains the heading:

PY Ep 301

ke-ke-me-na ko-to-na a-no-no to-so-de pe-mo ▫ 1 T 1

ko-to-no- -o-ko

Κεκείμενα κτοίνα ἀν-ονοι, τόσος σπέρμα: 132 units

κτοίνο- -οχω (ko-to-no-o-ko = κτοίνα + ἔχω)

Kekemena plots not subject to "benefit," so much seed: 132 units

plot- -holder

+ 12 line entries...

---

[380] Lambert, 1997.

[381] Ventris & Chadwick, 1973, p. 235.

[382] Lupack, 2008, p. 55; temple servants were not uncommon in the Ancient Mediterranean world, and the volume of individuals listed with this title may suggest that they were, indeed, an enslaved workforce for the Sanctuary at *pakijane*. What is curious, however, is that they are not treated in the documents as a group, but are listed individually by name.

[383] Sourvinou-Inwood, 1988; Sourvinou-Inwood, 1990.

The units of wheat from land *not* subject to the distribution of its benefits are tallied in the heading, as is indicated by the adjective *a-no-no*, and the sum is 132 units. This term, seen only twice elsewhere, has been translated by Carratelli and Webster as a compound of *o-na-to* ὄνατον and the alpha privative *an-*.[384] This translation has been generally accepted, and as a result the classification of the *ke-ke-me-na* land has been further particularized: there is common land from which one can gain a benefit, and common land from which one cannot. Depending on the nature of the benefit gained, it may be the case that this class of land is fallowed, depriving potential beneficiaries of the rights of usufruct, or it may indeed have a quality that makes it *non-taxable*. Interestingly, on all three individual surviving documents that record this type of land status, the unit quantity is identical: 132. On Ea 801 it belongs to *ku-ru-no*, a beekeeper in *ti-no*, and on Ea 922 it belongs to *a-pi-a2-ro*, a bronzesmith in *ti-no*. The tablet, however, is broken such that the next base-12 fraction has been lost, but the value □ 1 (120 units) survives. On the latter tablet the adjective was combined with the noun, rendering *ko-to-na-no-no*.

The term squeezed between the first and second line, *ko-to-no-o-ko*, is deeply puzzling. This is a compound word that conveys "plot-holding": κτοίνα + ἔχω, and it has been suggested that its placement just beneath the header bids the reader to supply it in each line in the following paragraph (n=5 lines). Each of these lines, which employs that standard formula, is quite crowded, so it seems logical that it was isolated for the sake of ubiquity.

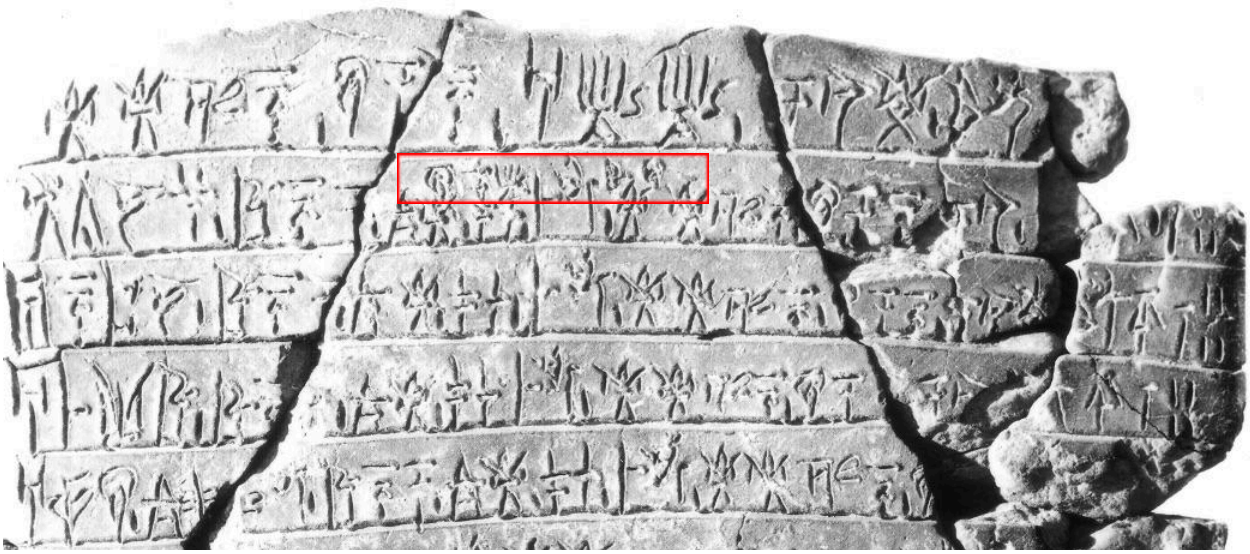


Figure 4.3 Upper section of PY Ep 301 with *ko-to-no-o-ko* highlighted in red box.

This assumption is supported by some of the leaf tablets containing the same information that were later compiled into the page tablet Ep 301, wherein the individuals listed in both paragraphs are accompanied by the term in question.[385] In the following paragraph, however, the *pa-ro da-mo* phrase has been replaced with the word *ko-to-no-o-ko* (n=7 lines), and the verb takes a less common form:

[384] PY Ea 801 and PY Ea 922: leaf tablets from *ti-no* that record *ke-ke-me-na* plots; Carratelli, 1954 and Webster, 1954.
[385] Eb 369, Eb 377, Eb 496, Eb 501, Eb 566, Eb 747, Eb 846, Eb 893.

e-ke-qe. Likewise, on PY Eb 297, which is an unusual document that may record a land dispute involving a *pakijane* priestess, the second party is documented as the *ko-to-no-o-ko*. However, in a later version of the document, PY Ep 704.5, this same second party is recorded as the damos. In these two cases it is clear that there is a relationship between the damos and the *ko-to-no-o-ko*, such that they seem interchangeable. There are at least two ways of reading this. Lejeune and Deger-Jalkotzy agree, arguing that it is the administrative organ of the damos, perhaps a council, tasked with administering *ke-ke-me-n*a land.[386] Lupack advocates for them *being* the damos, or at least a part of it.[387] Ventris and Chadwick, on the other hand, suggest that the uneven distribution of this term across the Ep set indicates that it has a unique meaning in the context of Ep 301 and that it in fact glosses the individual recorded in each line entry, rather than the damos. Given the prescribed etymology, this hypothesis would suggest that those listed with the inclusion of *ko-to-no-o-ko*, either on the line or implied by the header, are beneficiaries of damos land while being themselves plot-owners, and in contrast those whose entries do not include this term in fact do not have a separate landholding.[388]

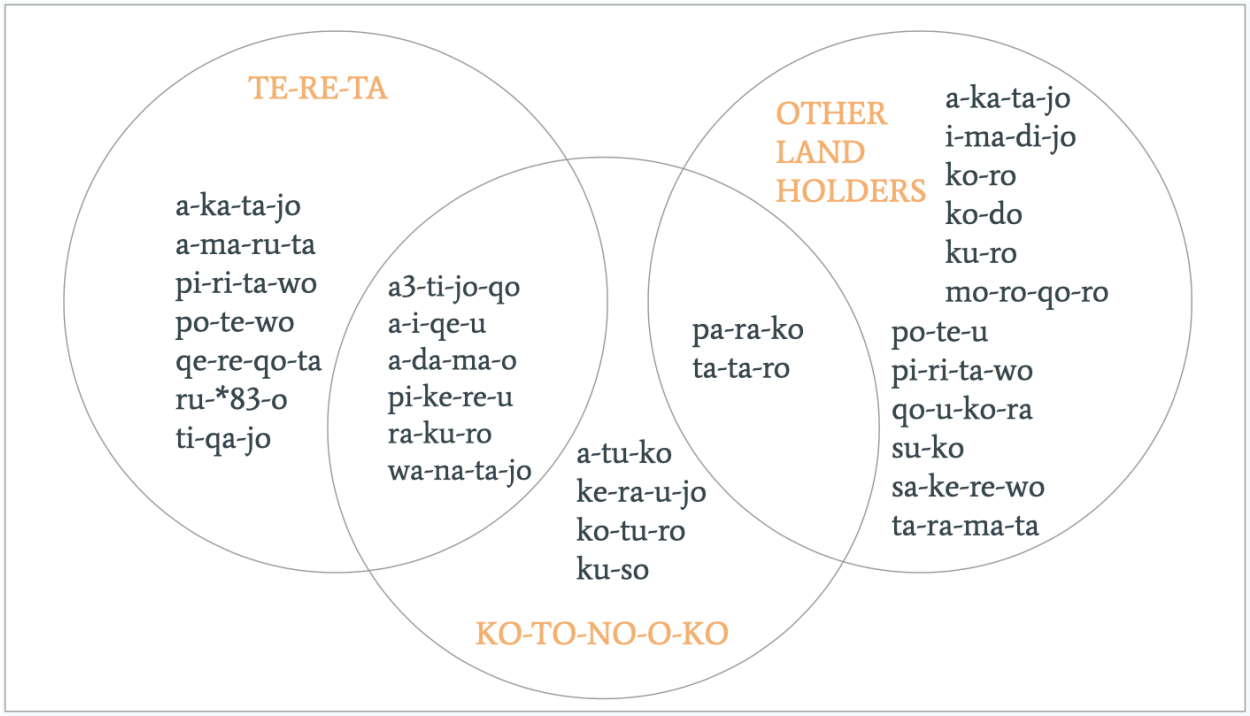


Figure 4.4 Venn diagram showing the correspondence between private landholders who appear in the documents (*te-re-ta* and other landholders without this title) and those listed as receiving a "benefit" from the damos whose entries contain the term *ko-to-no-o-ko*.

I am inclined toward the latter suggestion, the word is a gloss or title of private landholders, because the term was applied so consistently between the preliminary leaf tablets *and* the later collated

[386] Lejeune, 1972; Deger-Jalkotzy, 1978.
[387] Lupack, 2011, p. 212.
[388] They point to Ep 613, in which an individual, *pa-ra-ko* holds another type of land, *ka-ma*, and is explicitly marked as himself being a *ko-to-no-o-ko* with the participial phrase e-o (ἐών) *ko-to-no-o-ko*. This entry bolsters the suggestion that the term in question modified the person as opposed to being synonymous with the damos in land-record contexts (Ventris & Chadwick, 1973, p. 250).

page tablets. Of the 12 individuals associated with the term *ko-to-no-o-ko* on Ep 301, 8 were recorded on leaf tablets with this same term applied, one of whom (*pa-ra-ko*) appears on another document type (*ka-ma* type land) with the same title applied just to him (Ep 613 and Eb 173). On other documents in the Ep series that record those receiving the benefits of *ke-ke-me-na* land, the word appears neither on the leaf nor the final page tablet. This is highly suggestive. Rather than the second paragraph of Ep 301 including a synonym for the damos, therefore, the term *ko-to-no-o-ko* expresses information so important that the scribe would have *replaced* the phrase *pa-ro da-mo* in the line composition. While *pa-ro da-mo* was often implied within the context of the *ke-ke-me-na* formula, *ko-to-no-o-ko* must be explicitly articulated and was therefore privileged over the redundancy of the jettisoned phrase. More specifically, it is the restrictions of the physical line, in my estimation, that would have encouraged the scribe to use one over the other, rather than their direct relationship. A second important correlation is the fact that five of the *ko-to-no-o-ko*-affiliated individuals on Ep 301 are also known on other documents as *te-re-ta*, a title associated with having a *private* (*ki-ti-me-na*) landholding, in contrast with the common/public *ke-ke-me-na* category. I will return to the *te-re-ta* and this alternate category of land in section 4.1.1b, but for now I will emphasize only that there appears to be parallel or complementary language employed: 6 of the 14 private land-holders are listed along with the term *ko-to-no-o-ko*. Finally, in another tablet that conveys information about *ki-ti-me-na* type land, the first entry states that an individual holds the benefit of the plot belonging to *a3-ti-jo-qo*, one of the private landholders, followed by *ko-to-no-o-ko*. This is once again a crowded line, and one could imagine that the term, only applied in the first entry, ought to be supplied for the rest of the entries.[389] This strongly suggests that the word is a gloss or title of private landholders. This first tablet in the Ep series both contains the header, making it first in the series, and, perhaps, a special class of private land holders, who, like many others, also hold a benefit from common land that is administered by the damos.

The occupations of listed individuals in *pakijane* tend to cluster within the domain of the sanctuary (77%; see Figure 4.5a), which employs one priestess, a priest, an officiating priest who was likely in charge of sacrifices, a man designated as "of the Potnia," servants of the god, a key-bearer, a *di-ra* bearer, and likely others.[390] The unnamed "barleyers" of Eb 321 and Ep 704 have been likewise put forward as sanctuary personnel, suggesting that they would have functioned as priestesses charged with the performance of a barley ritual within a religious context, however the appearance of the moniker on a tablet associated with female labor-groups (PY An(4) 607) makes this theory less robust.[391] The other dominant group in this village is the *te-re-ta* (13%; see Figure 4.5a); though listed here as an occupation, the term may be a title more akin to a political office or status marker that bears certain affordances with respect to land tenure/rights. These individuals, though listed as beneficiaries

[389] PY Eo 247.

[390] Priestess: *i-je-re-ja* ἱερέα; priest: *i-je-re-u* ἱερεύς; sacrificing priest: *i-je-ro-wo-ko* ἱερο-ϝοργός; of the Potnia: *po-ti-ni-ja-we-jo*; servant of the god: *te-o-jo do-er-a/o* θεοῖο δούλη/ος; key-bearer: *ka-ra-wi-po-ro* κλαϝίφορος; *di-ra*-bearer: *di-ra-po-ro* *di-ra*-φόρος (*di-ra* has not been translated, but Ventris and Chadwick suggest that it was an erroneous spelling of *di-pte-ra-po-ro* "wearer of leather": PY Ea 814. This occupation is listed here as being associated with sanctuary personnel based on the second element, *-po-ro* φόρος "bearer", which often has religious connotations in the historical period).

[391] Barleyers: ki-ri-te-wi-ja κριθηϝία; *cf*. the κριθολόγος of the Opunitans; Lupack (2008) citing Bennett (1956) and Adrados (1956).

of *ke-ke-me-na* land, are more closely linked to *ki-ti-me-na* type land, which will be discussed in more detail in the following section: 5.1.1b *ki-ti-me-na*. Beneficiaries of *ke-ke-me-na* plots in *ti-no*, on the other hand, were not religious personnel but rather craftspeople and herdspeople. Craft-related professions included a male garment worker, a sewer/stitcher, a wheelwright/fitter, a bronze-worker, and a perfume maker.[392] The final occupational cluster is that of the herdspeople. Though these occupational titles are not always explicitly referenced in the E-series, many of those whose professions were not specified appear in other Linear B documents where such titles are supplied. These individuals have been listed elsewhere as shepherds, ox-pasturers, and a herdsman of unspecified quadrupeds.[393]

The case of the herdspeople is curious, since their "trade" is almost entirely absent from the land documents. It seems that pastoralist occupations were viewed as irrelevant by the Pylian record keepers, or that many people engaged in herdsmanship *in addition* to other, more noteworthy vocations, making herdsmanship a customary supplement to the community's daily/seasonal tasks. Based on a 1989 ethnography of pastoralists in northern Greece, it seems that the degree of integration of pastoral and agricultural pursuits is contingent on the landscape and the local cultivation practice.[394] Where there is abundant pasturage and few to no agricultural fields, oftentimes at higher altitudes, the pastoralists engage in year-round transhumance, moving to summer villages higher in the mountains and scattered winter villages in the lowlands based on the availability of pasture lands. Where pastoralists engage more with farmers, they schedule their use of the pasturage based on the crop cycle (stubble after harvest and fallowed fields) and utilize summer facilities in distant oak woods. Where agriculture is dominant, pastoralists exist in the niches and margins of cultivated fields, forming a patchwork agro-pastoral mosaic landscape tethered to a permanent settlement.

While we cannot say which model most aptly applies to *ti-no*, since its location is unknown, we can certainly gather from this ethnography that daily (10-15 km) and seasonal (100-150 km) mobility was as essential to the herding enterprise as the herders' relationships with farmers. It is a symbiotic coexistence based on informal agreements by which the farmer gains from field clearing, fertilization, and oftentimes the offer of milk, cheese, meat, and/or wool as much as the herder gains from the access

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[392] Sewing man: *ra-pte* ῥάπτης; wheelwright of the *lawagetas*: *ra-wa-ke-si-jo-jo a-mo-te-wo*; Bronze-worker: *ka-ke-u* χαλκεύς (this occupation is listed not in the E-Series, but in Jn(1) 478, which records apportionments of bronze to bronze-smiths); perfume-maker: *a-re-pa-zo-o* αλειφοζόος.

[393] Shepherd: *po-me* ποιμήν (this title is expressly assigned to the individual *A-pi-me-de* neither in the land documents nor the sheep documents, however, he appears in a list of shepherds in a place called *Ma-ro-pi* along with a quantity of rams in his flock (190) and the name of another individual who possibly manages the herd on a day-to-day level: PY Cn(3) 655); ox-pasturer: *qo-qo-ta* from βοῦς (this title did belong to an E-Series document that listed a man named *Ra-wo-do-ko* as holding a *ke-ke-me-na* plot, without mention of a "benefit" and written in small symbols at the top there is a qualifier, or gloss, of the term *ko-to-na* "plot" in the primary entry. It states: *qo-qo-ta-o ko-to-na* "plot of the ox-pasturer." While it is not clear exactly how this added detail fits into the logic of the rest of the entry, it may suggest that, since *Ra-wo-do-ko* has the plot, and the plot belongs to the ox-pasturer, then *Ra-wo-do-ko* is himself an ox-pasturer: PY Ea 802); herdsman of unspecified quadruped: since it is unclear what type of flock this individual, *Ta-ra-ma-ta*, holds, the title is not clear. In PY Ae(1) 108, however, another man, a goatherd, is recorded as watching over the *qe-to-ro-po-pi* (τετράποσι "quadruped") of *ta-ra-ma-ta*. This may suggest that his flock is also composed of goats, however, Ventris and Chadwick (1973) translate this term as "cattle."

[394] Chang, 1992.

to agricultural land.[395] It therefore may not have registered as an occupation, specialization, title, or profession, but rather a natural articulation of deeply entangled life-ways within rural communities.[396]

Occupation (*Pakijane*)	Count	Avg. Grain Measurement
Priestess	1	48
Priest	3	183
Servant of the god (male)	13	13
Servant of the god (female)	17	30
Personal servant	5	30
Landholder	7	68
Barleyers	1	228
Slave holder	1	552
Key-bearer	1	?
Pa-da-je-u	1	?
None specified	3	27
total	53	131

Occupation (*Ti-no*)	Count	Avg. Grain Measurement
Shepherd	2	54
Cowherd	2	30
Swineherd	1	?
Beekeeper	1	(a-no-no) 132
Bronze worker	1	(a-no-no) 120
Garment worker	1	12
Wheelwright of the Lawagetas	1	24
Sewers	1	24
Perfume-maker	1	216
Messengerof the Wanax	1	120
Qe-ja-me-no	1	300
None specified	5	164
Total	17	107.6

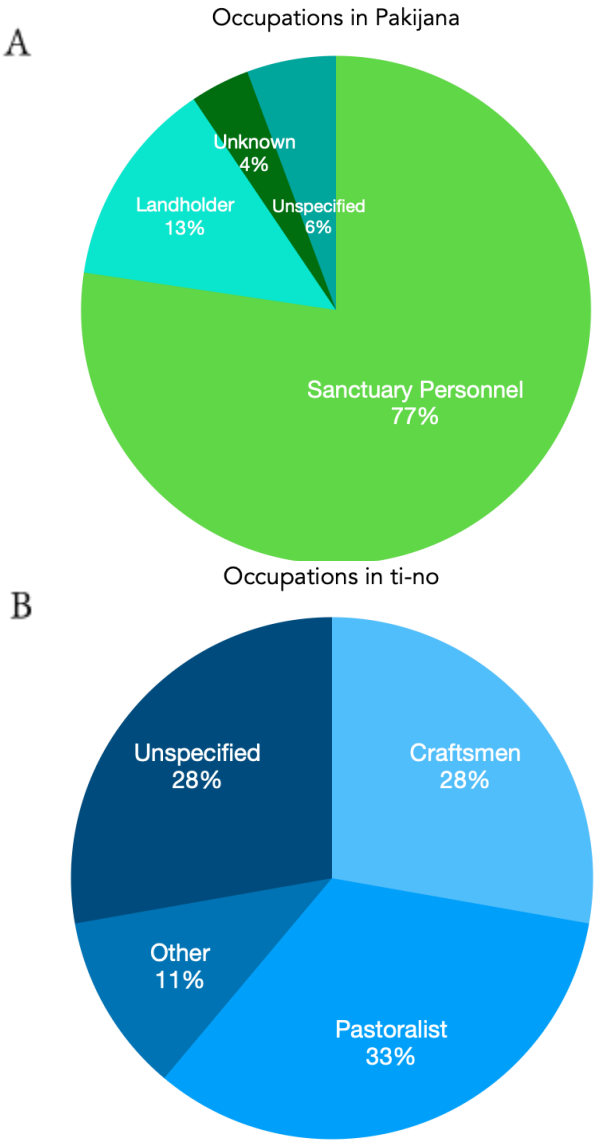


Figure 4.5 Tally of occupations listed among the beneficiaries of *ke-ke-me-na* plots in A) *pakijane* and B) *ti-no.* Based on the surviving line entries, an average was taken of the amount of grain measured per listed individual. Many of these quantities have wide ranges, such as the *ti-no* shepherds, who receive between 6 and 108 units. The pie charts reflect the proportions of occupation *type* frequency in each village.

The above mentioned transhumant system has been styled "vertical" pastoralism by Horden and Purcell. One could also expect small-scale, stationary stock-raising that could have supplied villagers

[395] Chang, 1992, p. 76.

[396] For more on the opposition to the presumed boundaries between pastoral and agricultural environments, and by extension the tension between pastoralists and farmers, see Horden and Purcell, 2000, pp. 80-87 and 197-201.

with year-round fertilizer, bush clearing, traction, and animal byproducts.[397] This would have been particularly valuable to farmers who require the aid of animal labor in tilling, clearing, and fertilizing operations, as well as nutritional supplements (either in the animal flesh itself or milk, cheese, and other secondary animal products) during the leaner months. It is quite likely, therefore, that both the *pakijane* and *ti-no* villagers benefitted from both forms of animal husbandry in the Mycenaean period.

Overall, the occupational distribution of those holding the "benefit" of the communal lands seems to indicate that at *pakijane*, a village founded around an important Pylian sanctuary, it is the sanctuary personnel who dominate the body of beneficiaries, while at *ti-no* it is the craftspeople and those whose vocation centers on animal husbandry. It has been established by Lejeune, Lupack, Deger-Jalkotzy, and Nakassis that these craftspeople and shepherds were engaged with Mycenaean society beyond a local level, as evidenced by their connections to state functionaries (*ke-re-te-u*: wheelwright *of the lawagetas*; *ka-ra-pi*: "armorer" or "garment worker") and connections to other state-supplied industrial enterprises (*e-u-me-de* the perfume-maker received oil from the palace in Fr 1184).[398] Ultimately, whatever the nature of the "benefit" received, it is clear that the palace was interested in rewarding contributors to its industrial and religious sectors and that those contributors were, for the most part, clustered geographically. Lupack brilliantly elaborates on Palmer's theory that *ti-no* was the domain of the *lawagetas* while *pakijane* was that of the *wanax* (the connection to the *wanax* at *pakijane* will become more clear in the next section 5.1.1b *ki-ti-me-na*) and Nikoloudis' theory that the *lawagetas* was tasked with organizing work groups for leather processing, suggesting that the *lawagetas* had familial ties with *ti-no* and thus recruited craftspeople for himself and the palace from a favored population. This seems quite likely, however the role of the herdspeople within the palatial system is less clear.

4.1.1b *Ki-ti-me-na*

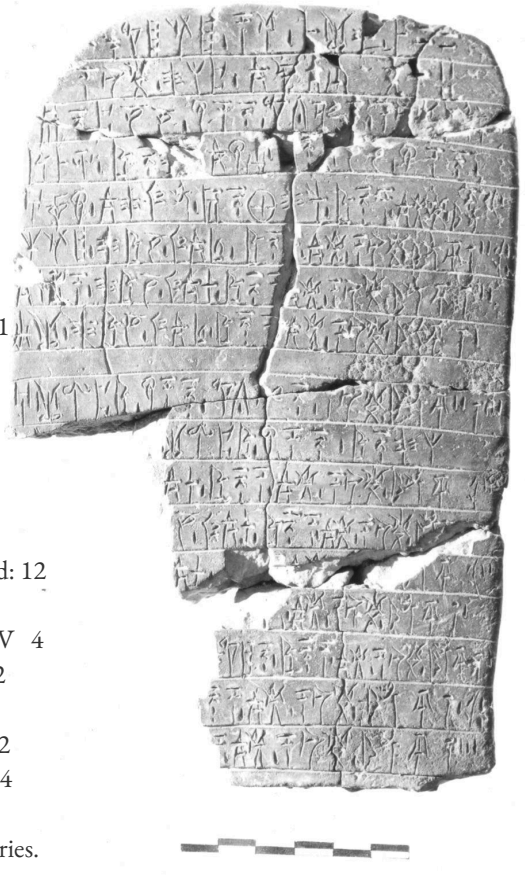
This next land type has a more ambiguous role in Mycenaean society than the "common" *ke-ke-me-na* type on account of the uncertainty around its distribution and control. In contrast to the prior formula, where the phrase *pa-ro da-mo* either explicitly or implicitly accompanies each ***ke-ke****-me-na*-type transaction, ***ki-ti****-me-na* transactions appear to have existed in an economic space apart from the damos. Here, individuals, rather than a corporate body, granted the "benefit" derived from the κτοίνα. The recipients are many, however, each individual tasked with distributing the *o-na-ta* are obliged only to 1-7 beneficiaries each, indicating either that their landholdings are much smaller than those of the damos, or the privileges of the *ki-ti-me-na* designation allowed for much more restricted access to it.

Despite its opaque function, the titular term has a surprisingly straightforward etymology. *Ki-ti-me-na* κτίμεναι, a middle participle formed from κτίζω, shares its indo-european root **ktei-* "inhabit, settle" with another important word in this series: κτοίνα "plot" and expresses "peopling, establishing, founding, colonizing." On these grounds the cultivated : fallow :: *ki-ti-me-na* :

[397] Horden & Purcell, 2000, pp.85-86.
[398] Deger-Jalkotzy, 1978; Lejeune, 1974; Lupack, 2015; Nakassis, 2013.

ke-ke-me-na reading has become popular, especially given the **ktei-* stem's acquisition of the sense "to plant, to cultivate" in historical Greek.[399] I, however, find it difficult to believe that a) the palace would be interested in recording and measuring fallowed fields while also failing to record their exact locations, b) the damos would have held/administered *exclusively* fallowed land, while individual landholders had exclusive rights to productive land, c) the "benefit" measured in grain volume could be distributed to *o-na-to* holders were the fields fallow, and d) that cultivated/fallow are functional categories at all, since crop rotation, fodder production, length of fallow period, and uncultivated vs. cultivated fallow periods are exceedingly variable between regions, plots, and an individual farmer's preferences. It is much more likely that the salient opposition between such designations is that of communal and private holdings, based not on the etymology, but on the discrete composition of beneficiaries: *ki-ti-me-na* : private landholder :: *ke-ke-me-na* : damos. The sense of the participle κτίμεναι does, however, complicate the picture. It could be that the *ki-ti-me-na* landholders lived on *their own land*, rather than in the village, and as such they had private access to its fruits, as opposed to the villagers, who shared access to communal land. Palmer has also posited that *ki-ti-me-na* land had been won from the wilderness, brought under cultivation and settled by an individual or family group set apart from the traditional, inherited village lands.[400]

Private landholders in the Ea, En, and Eo series (*ki-ti-me-na* land documents) seem to belong in two categories: *te-re-ta* and non-*te-re-ta*.



PY En 609

1. pa-ki-ja-ni-ja to-sa da-ma-te , □ (DA) 40
(and there are) so many *da-ma-te* in *pakijane*: 40

2. to-so-de te-re-ta e-ne-e-si □ (MAN) 14
And there are so many *te-re-ta* in it: 14

3. wa-na-ta-jo-jo ko-to-na ki-ti-me-na to-so-de pe-mo □ 2 V 1
The private plot of *wa-na-ta-jo*, so much seed: 252

4. o-da-a2 o-na-te[-re] e-ko-si wa-na-ta-jo-jo ko-to-na ,
So the ὀνατήρες (beneficiaries) hold the plots of *wa-na-ta-jo*

5. a-tu-ko e-te-do-mo wa-na-ka-te-ro o-na-to e-ke de pe-mo □ V 1
A-tu-ko, the messenger of the *wanax*, holds the "benefit" (so much) seed: 12

6. i-ni-ja te-o-jo do-e-ra o-na-to e-ke to-so-de pe-mo □ T 2 V 4
I-ni-ja, (female) servant of the god, holds the "benefit," so much seed: 32

6. e-*65-to te-o-jo do-e-ro o-na-to e-ke to-so-de pe-mo □ T 2
e-*65-to, (male) servant of the god, holds the "benefit," so much seed: 24

+ 11 lines dedicated to the landholdings of *a-ma-ru-ta* and his beneficiaries.

[399] For a discussion of the cultivated/fallow dichotomy advocates of this theory see Carratelli (1954) and Duhoux (1976); for a summary and valuation of various suggestions see: Lupack, 2008, p. 61-62; Ventris & Chadwick, 1973, p. 232-233.
[400] Palmer, 1954, p. 25.

The former group is well defined, tallied, and compiled into a series of larger page documents.[401] There are two extant versions of the *te-re-ta* series. In Version A, likely the later, polished version, the header in the first document, En 609, tallies the *da-ma-te* in *pakijane* (n=40), counted using the syllabogram □ with the sound value of DA, and the *te-re-ta* that are there as well (n=14), counted using the □ MAN ideogram. The first line has been often debated, and its position outside of the calculated categories of the rest of the E-Series documents gives few clues as to the context of the DA quantity. Ventris and Chadwick, Webster, and Furumark agree that it bears topographical information, perhaps measuring units of land; however, Carratelli contends that it is a derivative of *dam-/dom- and measures family units. The relationship between the landholders and the beneficiaries is fleshed out within each paragraph: each one is dedicated to one landholder and his beneficiaries, the plots and/or the fruits of the plots are measured, and the status of the beneficiaries is specified as *o-na-te-re* ὀνατήρες.

The total paragraph count in this series is 13, indicating to many that the landholders of each paragraph correspond directly to the holders of the title *te-re-ta*, counted in the header, though one appears to be missing.[402] Since the paragraphs are introduced with this same formula, measuring land/fruit of a landholder and establishing that the following beneficiaries were *o-na-to* holders (ὀνατήρες: an agent-noun formed from *o-na-to*) of the titular landholder, the *pa-ro x* formula is redundant in each line entry. We are already to understand that the *o-na-te-re* were "benefit" holders from the landholders. Version B, on the other hand, has an alternate structure. For the most part these tablets are shorter, featuring only the transactions related to one landholder each. The header tallying the *da-ma-te* and the *te-re-ta* is absent, and the relationship between the beneficiaries and the landholder is communicated *within* the line entries with a *pa-ro x* formula, much like the damos land documents. Interestingly, the title *te-re-ta* is wholly absent from Version B, however, it may have been strongly implied. For example, below is Version B of the document recording the same landholder as above:

PY Eo 211

.1 wa-na-ta-jo-jo ko-to-na ki-ti-me-na □ 2[V 1
private plot of *wa-na-ta-jo*: 242

.2 a-tu-ko e-te-do-mo e-ke-qe o-na-to pa-ro wa-na-ta[-jo] □ [V 1
a-tu-ko, messenger, holds the "benefit" from *wa-na-ta-jo*: 2

.3 i-ni-ja te-o-jo do-e-ra e-ke-qe o-na-to pa-ro wa-na-ta[-jo] □ [T 2 V 4
i-ni-ja, (female) servant of the god, holds the "benefit" from *wa-na-ta-jo*: 32

.4 e-*65-to te-o-jo do-e-ro e-ke-qe o-na-to pa-ro wa-ta-jo̯ □ [T 2
*e-*65-to*, (male) servant of the god, holds the "benefit" from *wa-na-ta-jo*: 24

.5 si-ma te-o-jo do-e-ra e-ke-qe o-na-to pa-ro wa-na-ta-jo □ T 1 [
si-ma, (female) servant of the god, holds the "benefit" from *wa-na-ta-jo*: 12

[401] In the order suggested by Ventris and Chadwick (1973): En 609, En 74, En 659, and En 467 (Version A) and Eo 211, Eo 224, Eo 276, Eo 247, Eo 160, Eo 444, Eo 351, Eo 471, Eo 281, Eo 269, Eo 278, Eo 268, and Eo 371 (Version B).

[402] For more discussion on the missing 14th *te-re-ta* see: Lupack, 2008, p. 52; Lane, 2012. For a rebuttal against the idea that the 14 *te-re-ta* have anything to do with the listed landholders, see Brown, 1956, p. 395.

There are, however, those with reservations about the *te-re-ta* attribution. Brown contends that the 13 paragraphs of versions A and B are artificial, a "pure fantasy, gleaned from a number of more or less unrelated records."[403] He correctly points out that the term is only mentioned in the header of En 609, never in the short primary documents from which Version A was compiled, and that the series assembled by scholars presumably attributed to the 14 *te-re-ta* does not give any indication that it belongs together. While this is compelling, Brown fails to mention the appearance of the term on PY Eo 224, in which one of the potential *te-re-ta*, *wa-na-ta-jo*, is listed as an *o-na-to* holder from the plot of *a-ma-ru-ta* with the occupational epithet "*te-re-ta*." Curiously, in Eo 224 the *o-na-to* holders of the land belonging *a-ma-ru-ta* are recorded, however, in the first two entries his name was erased and *pa-ro pa-ra-ko* was written over it. In the sixth entry, it was replaced with *pa-ro ta-ta-ro*. Both of these replacement names appear in Ep 301 and are accompanied by the title *ko-to-no-o-ko*. Were they *also te-re-ta*, then the count within the 13 paragraphs would actually be 15, rather than 14. This, it seems, is not an omission that is paired with any implied information, like the Version B tablets, because the final version of the *te-re-ta* series contains a header with totalling data: *to-so-de te-re-ta e-ne-e-si* □ 14 (τόσος δὲ *te-re-ta* ἔνεισι; there are so many *te-re-ta* therein: 14 men).

Both in *pakijane* and in *ti-no* leaf tablets containing a similar formula have been recovered, featuring the *pa-ro x* formula and a holder of an *o-na-to*; however, the nature of *ki-ti-me-na* designation is absent. This is not unprecedented, since many of the shorter *ke-ke-me-na* records lack such a designation, in which case the *pa-ro da-mo* phrase implies the communal land classification. In light of this, it is possible, though not certain, that there were more *ki-ti-me-na* landholders in both villages who were not counted amongst the 14 *te-re-ta* but who distributed a benefit nonetheless. The table below lists the landholders in both villages and their professional fields, which in many cases are gleaned from a prosopographical analysis across other Pylian records. Those with the title *ko-to-no-o-ko,* who are not considered *te-re-ta*, have been included in the "other landholders" category; however, aside from *pa-ra-ko* overwritten on Eo 224 there is no correspondence between these *ko-to-no-o-ko* title holders and an *o-na-to* transaction. To clarify, those "landholders" with *only* the *ko-to-no-o-ko* title have no obligation to ὄνασθαι members of the community, while *ko-to-no-o-ko* who are also *te-re-ta* do. If we exclude the former category from the list of private landholders, there are an additional 5 who hold land *with* an obligation but were not counted amongst the 14 *te-re-ta.* Interestingly, one of such non-*te-re-ta* property owners, *su-ko*, was recorded as *te-re-ta su-ko* on Ep 613 and Eb 139. This has prompted Carlier to suggest this individual as the missing 14th *te-re-ta*.[404] Nevertheless, were the four other landholders in *pakijane* considered *te-re-ta*, the total would be 18 (or 19, depending on your reading of Eo 224). If the title is thus *not* synonymous with or ubiquitously applied to landholders, what then is its meaning/function as applied?

Etymologically it appears related to the Archaic Greek word τελεστάς "magistrate, official" from τέλη "services due" or τέλος "burden of service."[405] Through the prism of Mycenaean

[403] Brown, 1956, p. 395.

[404] Carlier, 1987.

[405] An earlier suggestion from Ventris and Chadwick (1973) was τηρέτης "overseer," however, this suggestion was rejected without explanation by its original proponents. Ventris & Chadwick, 1973, p. 234; Palmer, 1963, p. 193. The word root proposed by Ventris and Chadwick (1973) is τέλη, while Palmer (1955) prefers τέλος.

socio-political order within the land documents, the vagueness of the title has been interpreted as functioning like a feudal baron, vassal,[406] or religious functionary, inferred by the use of τελεστάς in historical Greek religious contexts.[407] Based on the content of the E-series, a document from Knossos recording 45 *te-re-ta* and 5 carpenters from a village called Aptawa on Crete (KN Am 826), and the earliest attestation of the Greek τελεστάς on an Elean inscription that groups the citizen body as αἴτε ϝέτας αἴτε τελεστὰ αἴτε δᾶμος *(IvO* 9), Palmer concludes that within the Mycenaean context the title was associated more with a burden of service to the *wanax* than to its later religious functions.[408] He likewise provides a contemporaneous analog from the Hittite land documents that distinguishes the "man of the (feudal) service," whose landholding is procured from the palace, from the "man of the tool," the source of whose holding is the village.[409] Given the connection between *pakijane,* the *wanax*, and the *te-re-ta,* this appears quite plausible, and the "burden" of the service may very well be evident in the pairing of the title with a species of transaction that benefits or aids (ὀνίνημι "aid, benefit" –> *o-na-to*) 1-7 villagers each.

While the title seems tethered to the palace and to privately held real properties, it was clearly *not* understood as professional employment or occupation in the sense that labor is exchanged for wages. In fact, the *te-re-ta* belonged to diverse economic sectors. 23% of the *te-re-ta* were engaged in the bronze industry, appearing in the Jn-Series listed as bronze smiths (*ka-ke-we*), 15% were craftsman (fuller: *ka-na-pe-u*; potter of the *wanax*: *ke-ra-me-wo wa-na-ka-te-ro*), and 15% were herdspeople (shepherd: *po-me*; swineherd: inferred from a livestock inventory). Additionally 1 out of the 13 was possibly a beet harvester (*te-u-ta-ra-ko-ro* from τεῦτλον "beets"),[410] and 1 was a priest. Their holdings, measured in dry grain volumes, varied significantly, ranging from 132 to 996 liters, as did their "benefit" distribution volumes. It has not yet been established whether the number of units held by each *te-re-ta* included or excluded the distribution, whether this tally is complete *before* one factors in the line entries that follow, or not. I, however, am inclined to believe that the holdings listed as belonging to the *te-re-ta* at the top of each paragraph was their possession *after* one accounts for the distribution to the *o-na-te-re,* since, in the case of *a3-ti-jo-qo*, the landholder would be left with a mere 8 units, less than their beneficiaries (all beneficiaries received at least 12 liters from *a3-ti-jo-qo*).

PY En 74

11	a3-ti-jo-qo ko-to-ṇạ ki-ti-me-na to-so-de pẹ-mọ	□ 1 T 5 V 4	principal
12	o-da-a2 o-na-te-re e-ko-si a3-ti-jo-qo ko-to-na		
13	e-pa-sa-na-ti te-o-jo do-e-ra o-na-to e-ke to-so-de pe-mo	□ T 2	
14	ku-*63-so꜀ ⌟ṭẹ-o-jo do-e-ro o-na-to e-ke to-so-de pe-mo	□ T 1	
15	ta-ra2-to te-o-jo do-e-ro o-na-to e-ke ṭọ-so-de pe-mo	□ T 1	
16	we-te-re-u i-e-re-u o-na-to e-ke to-so-de pe-mo	□ T 5	
17	e-ko-to te-o-jo do-e-ro o-na-to e-ke to-so-de pe-mo	□ T 1	distribution total
18	ko-ri-si-ja te-o-jo do-e-ra o-na-to e-ke to-so-de pe-mọ	□ T 5	

[406] Palmer 1955, pp. 190-196.
[407] The initiation priests, or initiants, involved in the Mysteries: Adrados, 1970; Brown, 1956; Chadwick, 1957.
[408] "Everywhere the religious language is a repository of archaism" (Palmer, 1963, p. 195); *cf*. Τεμενος.
[409] Palmer, 1963, pp. 190-191.
[410] This reading has been contested, see: Palmer, 1963, p. 137.

A3-ti-jo-qo : 188 liters — % total (180+188) distributed = 49% ; *A3-ti-jo-qo* keeps more than half of his holding
Beneficiaries total: 180 liters — % principal (188) distributed = 95% ; *A3-ti-jo-qo* keeps only a small fraction (8 liters)

Ki-ti-me-na landholders/te-re-ta (Pakijana)	Professional Field	Possession (liters)	Distribution (liters)	*o-na-to* % total (possession +distribution)	*o-na-to* % principal (possession)	*o-na-to* from damos?
a3-ti-jo-qo	ko-to-no-o-ko	188	180	49%	95%	174
a-i-qe-u	ko-to-no-o-ko	264	18	6%	7%	72
a-da-ma-o	Bronze	216	32	13%	15%	48
a-ka-ta-jo	Fuller	384	24	6%	6%	
a-ma-ru-ta		276	90	24%	33%	
pi-ke-re-u	ko-to-no-o-ko	312	96	23%	31%	48
pi-ri-ta-wo	Potter of the Wanax	132	76	36%	57%	
Po-te-u	Swineherd	288	0	0%	0%	
qe/pe-re-qo-ta	Priest	276	138	33%	50%	
ra-ku-ro	ko-to-no-o-ko	138	6	4%	4%	?
ru-*83-o	Beet gatherer?	180	98	35%	54%	
ti-qa-jo	Shepherd/Bronze	996	0	0%	0%	
wa-na-ta-jo	*te-re-ta*/ko-to-no-o-ko/ Bronze	252	70	22%	28%	60

Other Landholders (Pakijana)	Professional Field	Possession (liters)	Distribution (liters)	*o-na-to* % total (possession +distribution)	*o-na-to* % principal (possession)	*o-na-to* from damos?
a-tu-ko	Bronze/ko-to-no-o-ko					?
i-ma-di-ja	Bronze		12			348
ke-ra-u-jo	ko-to-no-o-ko					48
ko-tu-ro2	ko-to-no-o-ko/ pa-da-je-u					12
ku-so	ko-to-no-o-ko					6
pa-ra-ko	ko-to-no-o-ko		36			84
pe-re-qo-no	Oxherd		74			
po-te-u	Swinherd	288				
su-ko						
ta-ta-ro	ko-to-no-o-ko					6
ti-qa-jo	Shepherd	996				

Ki-ti-me-na Landholders (*ti-no*)	Professional Field	Possession (liters)	Distribution (liters)	*o-na-to* % total (possession +distribution)	*o-na-to* % principal (possession)	*o-na-to* from damos?
e-u-me-de	Perfume maker	216				
ko-do	Shepherd	174	168			170
mo-ro-qo-ro	Shepherd of the Lawagetas	258	168			
o-pe-te-re-u	qe-ja-me-no	240				300
qo-u-ko-ro	Oxherds	288				
sa-ke-re-u	Priest	792	12			
ta-ra-ma-ta	Herder	690				114

Other Landholders (*ti-no*)	Professional Field	Possession (liters)	Distribution (liters)	*o-na-to* % total (possession +distribution)	*o-na-to* % principal (possession)	*o-na-to* from damos?
ku-ro2	Of the Lawagetas		24			
ru-ko-ro	Of the Lawagetas		72			
Swineherd	Of the Lawagetas		408			
Beekeeper			228			

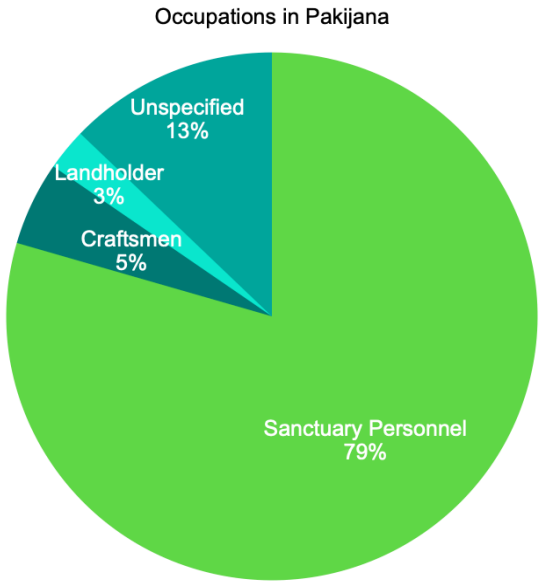
Table 4.1 *Te-re-ta* and other landholders from *pakijane* and *ti-no* listed alongside their occupational/professional fields, their principal possession listed at the top of the paragraph, their total distribution, the proportion of their holding that is distributed (this can be understood either as a percent of the principal + distribution, or as a percentage of the principal only), and the benefit distributed to them from the damos.

With this in mind, the proportion of the overall holding that was distributed can be ascertained from the column labeled "*o-na-to* % total," in Table 4.1, since the entire holding *included* that which was distributed, rather than the principal listed at the top of the paragraph alone.

Much like the *ke-ke-me-na* "benefit" allotments, those derived from private land went mostly to sanctuary personnel at *pakijane* and craftsmen at *ti-no*. Interestingly, however, the pool of recipients was smaller, and many received an *o-na-to* from multiple landholders.

Occupation (*Ti-no*)	Count	Avg. Grain Measurement
Priest	1	24
Di-ra bearer	1	12
Shepherd	1	12
Cowherd	0	0
Swineherd	0	0
Beekeeper	0	0
Bronze worker	0	0
Garment worker	4	27
Wheelwright of the Lawagetas	3	116
Sewers	0	0
Perfume-maker	1	132
Messenger of the Wanax	0	0
Of the Lawagetas	3	20
Qe-ja-me-no	0	0
None specified	5	45.6
Total	19	48.57

A



Occupation (*Ti-no*)	Count	Avg. Grain Measurement
Priest	1	24
Di-ra bearer	1	12
Shepherd	1	12
Cowherd	0	0
Swineherd	0	0
Beekeeper	0	0
Bronze worker	0	0
Garment worker	4	27
Wheelwright of the Lawagetas	3	116
Sewers	0	0
Perfume-maker	1	132
Messenger of the Wanax	0	0
Of the Lawagetas	3	20
Qe-ja-me-no	0	0
None specified	5	45.6
Total	19	48.57

B

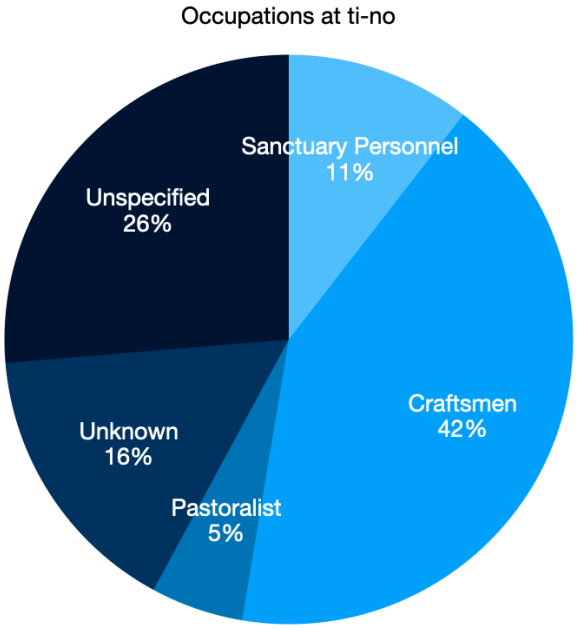


Figure 4.6 Tally of occupations listed among the beneficiaries of *ki-ti-me-na* plots in A) *pakijane* and B) *ti-no.* Based on the surviving line entries, an average was taken of the amount of grain measured per listed individual. Many of these quantities have wide ranges, such as the *ti-no* shepherds, who receive between 6 and 108 units. The pie charts reflect the proportions of occupation *type* frequency in each village.

For example a servant of the god, *ta-ta2-to*, received distributions ranging from 6-32 liters from 4 different *te-re-ta*, some of whom counted him as their sole beneficiary. Many of those who benefited from communal land, however, were absent. Only 1 priest, 1 shepherd, and 1 landholder, and 0 bronze workers, key-bearers, or barleyers received a distribution. Finally, despite many servants of the gods receiving distributions from multiple landholders, the total number of named individuals is 21, in contrast with the 30 who appeared in the *ke-ke-me-na* series.

4.1.1c *Ka-ma*

A subset of the communal land type, *ka-ma* land, showcases an obligation attached to land tenure that is at once more explicit than that of the *te-re-ta* yet somehow much more opaque with respect to the nature of the obligation itself. The land is described in the tablets as *ke-ke-me-na*; however the language of the transaction is scaffolded by iterations of the word *ka-ma* (*ka-ma-e-u; ka-ma-o*), which has been conventionally understood as related to the verbal root κάμ- "labor," expressed in later Greek in κάμνω "to work" and κάματος "toil, trouble."[411] It has also been suggested that the word may rather be correlated with Hesychius' gloss of the Cretan καμάν. τὸν ἀγρόν "field."[412] The set dealing with this variety of transactions is composed of 14 tablets that have a distinctive parlance. To begin with, those who administer *ka-ma* plots were titled *ka-ma-e-we* (sg. *ka-ma-e-u*), and were equivalent to the *te-re-ta* in that their tenure was distinct from the damos. This is evident in Ed 411, where the aggregate holdings (measured in grain) of the *te-re-ta* and the *ka-ma-e-we* were listed together on a leaf tablet:

PY Ed 411

1 aggregate pa̱-[ ]*te-re-ta* 𐄁 5,304+ liters
2 *ka-ma-e̱-we* 𐄁 6,984+ liters



EDGE: servant (f.) of the god [

The attached obligation to their title/holding is conveyed through common taxation vernacular, *o-pe-ro* ὀφείλω "owe, be bound to render," as well as the hapaxes *to-e* and *to-me*, which Palmer posits are variations of a verb with the root θω- meaning "pay a fine" (here: θώιοι, θώη, θῶμεν).[413] Another pair of familiar terms carry a message of obligation: *te-re-ja* and *te-ra-pi-ke* (later: θεραπεύω), verbs that share genes with *te-re-ta* and convey a sense of "rendering a service."

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[411] Palmer, 1963, p. 207; Ventris & Chadwick, 1973, p. 261.
[412] Ibid.
[413] Palmer, 1963, pp. 206-207. Ventris and Chadwick (1973) offer a less convincing argument for *to-e* being an alternate spelling of the dative pronoun τῷ and *to-me* being an alternate dative form of *to^{s}mei* (*cf*. Sanskrit *tasmai* "to that").

Name	Title(s)	Landholding (and Obligation)	Action
(1) ne-qe-wo	e-da-e-wo	ka-ma o-pe-ro du-wo-u-pi te-re-ja-e	e-me-de te-re-ja
(2) [ko-i-ro]		ke-ke-me-na ko-to-na ka-ma-e-u	wo-ze-qe
(3) su-ko (?)	te-re-ta, po-ro-du[-ma	o-pe-ro-qe du-wo-u-pi te-re-ja-e	o-u-qe wo-ze
(4) a_3-ke-re-u	ạ-si-to-po-qo	ka-ma e-ke-qe	wo-ze-qe
(5) a-.-ke-re-u	i-je-ro-wo-ko	ka-ma-e-u o-na-to e-ke	wo-ze-qe
(6) sa-sa-wo		o-na-to e-ke ka-ma-e-u	e-pi-qe to-me te-ra-pi-ke
(7) e-u-ru-wo-ta	te-o-jo do-e-ro	e-ke-qe ka-ma o-na-to	wo-ze-qe
(8) pe-re-qo-ta	pa-de-we-u	e-ke-qe ka-ma o-na-to si-ri-jo ra-ke	
(9) pa-ra-ko (and po-so-re-ja)	ko-to-no-o-ko (te-o-jo do-e-ra)	e-ke-qe ka-ma (e-ke o-na-to pa-ro pa-ra-ko)	
(10) ko-tu-ro_2	mi-ka-ta, pa-de-we-u	ka-ma-e-u e-ke-qe	wo-ze-qe

Table 4.2 The 10 *ka-ma-e-we* recorded on PY Ep 613.1–13. Numbers in parentheses refer to individuals in order of appearance on the tablet (Nikoloudis, 2014, table 17.1).[414]

In most cases, the substance of the service/labor obligation is that these individuals must *wo-ze*, a verb that may be interpreted as *worzei* "work" or "plough," or from ϝοιζεύς "an obligation attaching to a holding."[415] The formula deploys combinations of these three encumbrances (Table 4.2) and much larger volumes of grain: 120 - 1,200 liters.[416]

Interpretations of these inscrutable documents have varied, mainly because the genre of attached obligation is omitted from the text. Early in their consideration, Martín Ruipérez suggested that the implied labor was agricultural, obliging *ka-ma* holders to plough communal properties, while Del Freo suggests that the *ka-ma-e-we* were to transform unused land into cultivable properties.[417] Certainly the large volumes of grain and relationship with *ke-ke-me-na* land would support either of these suggestions. A large, fallowed "outfield," perhaps subject to bush or forest fallow cycles, would require intensive labor to clear and cultivate. Nikoloudis builds on this idea in her hypothesis that the newly cultivable land would have undergone this transformation such that it would support the dependent palatial workforce.[418] Based on the pollen record, I might also suggest that the emphasis on

[414] Del Freo, 2009; Ruipérez, 1957, pp. 174-206; Nikoloudis, 2014.

[415] Palmer posits that this word, found on the Gortynian Code in the phrase ἐπι χώραι ϝοικίων as well as an inscription from Cyprus including the phrase ἰ δὲ κ' οἰκίσι πείση τὸν νόμον, ις a technical term that reflects an obligation attached to a landholding. Moreover, the former inscription has even more thematic links to the *ka-ma* set, as it mentioned "paying a penalty" and a deposit in a treasury (here: a large volume of grain?). The complete excerpt is as follows (Palmer's translation): "Aristomachus deserted his plot. Instead of him I installed a 'house dweller' (=occupier). Consequently I did not deposit in this treasury the sum due in respect of the plot. If he should *woik-* it, he shall pay the customary sum (?)" (Palmer, 1963, p. 204).

[416] These volumes reflect the holdings of the *ka-ma-e-we*, however there are also *o-na-to* holders of *ka-ma* land who have grain volumes commensurate with the *o-na-to* holders of the other land types.

[417] Nikoloudis, 2014, p. 228.

[418] Ibid.

olive cultivation in the Pylian "outfield" and on the steep slopes of Englianos Ridge that ramped up after 1500 BCE may have been a primary or complementary objective.[419]

4.2 ***Inherited Interpretations and the Problems with the Leasing Paradigm***

The volume of documents dedicated to recording the nature and distribution of land parcels and the meticulousness with which the palace scribes documented the minutiae of every transaction convey the import of these accounts, however, despite the fact that they are at this point decipherable, fundamental questions about the nature of the transactions and the palace's concerns/interests still persist. Indeed these documents register land parcels and involve, likely, territorial claims by individual users, but they certainly could not have functioned as a *land register* proper (which is how the series is often offhandedly styled) and/or cadastral record. There is neither a physical description nor spatial orientation information provided concerning the κτοίνα subject to the obligation of the *o-na-to*, and therefore, the purpose of the register, to formally protect the rights of its holder/user and streamline property sales/transfers, would be functionally impotent. Were boundaries ever contested or encroached upon, or were there ever inquiries about inherited rights of access, these records would have been of no aid at all. Rather, the focal point of the transaction is the *o-na-to*, given to an individual by another, originating from a landholding, and measured in dry grain volume calculations. The records, therefore, served to buttress the disclosure and/or validity of the *exchange* of a "benefit," not that of the parcel itself.

4.2.1 *The Proxy Hypothesis*

Since the mid-1950s the interpretation of the grain measurement as a land measurement proxy has been universally accepted, and as a result, the content of the transaction *must* be land or land-use rights. Below is a sampling of the succinct treatments of the "lease" translation:

> [the *o-na-ta*] apparently constitute some kind of subordinate title to the use of particular fields, and we have translated them as "leases" (Ventris & Chadwick, 1973, p. 235).

> ...the *o-na-to* is considered to be a benefit, or to provide a profit for the people who lease the land, the *o-na-te-re* (Lupack, 2008, p. 51).

> [*ko-to-na ki-ti-me-na*] is always "leased" from an individual and [*ko-to-na ke-ke-me-na*] from the *damos* (Palmer, 1963, p. 187).

> *O-na-to* is conventionally interpreted as a neuter noun ὄνατον, which did not survive in classical Greek but which would refer to a beneficial use of land (perhaps corresponding roughly to the English term "lease"), if its stem is correctly identified with that of the verb ὀνίνημι "confer a benefit upon (Hooker, 1980, p. 138).

[419] See Chapter 2.

The following two examples express more unambiguously the leap from "benefit" to "lease," which was subtextual or inferred in the above examples:

> From these *ko-to-na* and from individual holders, certain parcels are leased (we cannot translate "sold" while the *ko-to-no-o-ko* retains an interest) as *o-na-to* (Bennett, 1956, p. 120).

> Within this structure we find that land is parceled out basically for "holding" as a "benefit." The exact term used for such a landholding parcel is an onāton. We may compare the equivalent Carolingian land-parcel allotment, a beneficium. The Mycenaean term onāton shares with the Latin term an underlying sense of usufruct, namely that by holding and using the land, the holder gains a "fruit" of his or her labor (usufruct), "is done well or does well," i.e., he benefits, by so doing (beneficium), and finds so doing "useful and helpful and advantageous"––this is the root meaning of onāton as seen in the historical Greek verb ὀνίνημι. (Palaima, 2015, p. 624-625).

This consensus appears quite logical. As Bennett and Palaima so thoughtfully illustrate, the benefit of land belonging to someone else, whose continued interests were manifest and noteworthy on each line of each document, *must* in practice have operated like a lease. This interpretation, however, wholly hinges on the acceptance of the grain measurement as a notional acreage proxy, which is an unsettled (and ubiquitously ignored) debate. Ventris and Chadwick caution that "it is not clear whether the amounts of seed grain are a record of an actual transaction (an issue from the royal granaries?), or merely a theoretical way of expressing the acreages of the land (being recorded for the purposes of taxation?)."[420] While they go on to argue that "there is evidently an accepted density of sowing which makes it unnecessary to record the acreages in other measures of area" and muster a Bronze Age Nuzian analogue in which such a proxy was deployed (a unique example in ancient Mesopotamia), in my view this attribution is at best untested and at worst wildly misleading.[421]

Interestingly, in the case of the Nuzian *imêru* "donkey load" land measurement system, the state officials had to develop legal conventions to address the ambiguity and "instability of the *imêr* measure."[422] A standard measure was deployed in royal accounts that differed from such measures in the field and from those of local administrative systems; to mitigate the discrepancy they added detailed descriptions of the borders and a clause stating that, "if the extent of the land proved to be larger than numerically indicated, it should not be reduced; if it were smaller, it should not be."[423] Clearly this mode of defining parcels and boundaries was troublesome and inexact, and in one text they even specify that 4 *imêru* were required to cultivate a 5 *imêru* field, a clear failing of this mode of area estimation.[424]

Not only is the example from the Nuzi documents unique amongst the far more ubiquitous measurement scheme based on ox-days and proven to be a fallible, blunt legal instrument, but it also underlines the issue of seed *quantity* in the Pylos documents. Ventris and Chadwick rightly point out

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[420] Ventris & Chadwick, 1973, p. 236.
[421] Ibid.
[422] Lewy, 1942, p.24.
[423] Lewy, 1942, p. 25: "See, e. g., N 9, 15 f.: sum-ma eqlu mad 16 la i-na-ak-ki-sú sum-nta eqlu sihir la ů-ra-ad-dá. This clause occurs (sometimes in a slightly different wording) in the texts N 9; 61; 83; 85; N II 212; N IV 402; N VI 602;H V 55; 56; H IX 19; 20; AASOR XVI, no. 58."
[424] Lewy, 1944, p. 73.

that there is general agreement among ancient (and modern) sources that the sowing requirement for 1 hectare of land is between 150 and 200 liters.[425] The *imêru* is roughly 134 liters, so it follows that such a volume is used to cultivate the eponymous area of slightly less than 1 hectare. The Pylian holdings and, most strikingly, the distributions are miniscule in comparison. The basic unit of measurement is the grain ideogram 𐄁, which constitutes 120 units, from which smaller fractions were devised.

𐄁 = 120 units
𐄇 = 12 units (1/10 𐄁)
𐄈 = 2 units (⅙ 𐄇; 1/60 𐄁)

The absolute value of the units recorded are harder to glean, but Ventris and Chadwick make an argument for them being equivalent to 1 liter, making the relationship 1:1.[426] Once again, the basic unit of measurement, 𐄁, amounts roughly to the volume of (wheat) seeds required to plant one hectare.

4.2.2 *Puzzling Parcels*

The *te-re-ta* in *pakijane*, who held private land and made distributions to 1-7 villagers from it (in whatever form), held for themselves on average 300 liters of seed, accepting the equivalence of the Mycenaean unit to one liter. Were the seed-as-proxy-for-land hypothesis correct, this would entail 1.5 - 2 ha of land. In *ti-no* the measurements are similar, if somewhat larger, averaging 380 liters and 1.9 - 2.5 ha of property held for private use, not distributed in the form of a lease. If we assume an intensive cultivation practice (grass/no fallow), the most economic use of space, this would exceed the 0.86 ha bare minimum requirement in a good year, allowing no margin of error for inevitable crop failure and/or poor yields, for a family of 5 to subsist and may even have provided a small yearly surplus in produce.[427] Introducing any periods of fallow, especially a bush fallow cycle, or interannual variability in yield would have made a parcel of such a size insufficient for basic subsistence.[428] The *distribution* of *ki-ti-me-na* land, however, was on average a paltry 22.6 liters, just 13% of what would be required to sustain one family. The *ke-ke-me-na* distributions tended to be somewhat larger and average 55.1 liters each, but were still just 32% of the minimum land requirement for a family engaging in cultivation practices that involved the most modest parcels.

These were miniscule properties, some even as small as 2 liters, and their leasing would have hardly been beneficial to the majority of the *o-na-to* holders. Ventris and Chadwick highlight this issue as well and offer two suggestions as to how to reconcile the metrics while conserving the proxy hypothesis. First, they posit that the implied land area ought to be doubled, assuming that half of every

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[425] Ventris & Chadwick, 1973, p. 237 referencing Neo-Babylonian texts, Cicero, Columella, and the Talmud; see also Lewy (1944, pp. 72-73) for more examples from Ancient Mesopotamia and the modern US and France.

[426] See pp. 58-60 in Ventris and Chadwick (1973) for a very detailed survey of Mycenaean vessel volumes and monthly rations for armies and others across the Mediterranean that inform this estimate.

[427] The 0.86 ha estimate is not specific to Greece, and in fact does not account for *any* variability in harvest quantity. In southern Greece in particular the hazards of climatic variability compel poor farmers to cultivate 1.5-2 ha so as to mitigate frequent poor yields.

[428] Bush fallow cycles require ~6.5 ha of land to sustain a family of 5; see 2.3.2c in Chapter 2: *Environmental Reconstruction* for more information about these strategies and their individual land requirement.

holding would be fallow in any given sowing season. Even if this brought the properties into a suitable subsistence range, which it does not, fallowing practices are highly variable. The quality of the soil, the crop sown, and the decisions of the farmer make a yearly alternating cycle default setting unlikely. As was mentioned in Chapter 2, 19th and early 20th century farmers in southern Greece, hampered by low annual rainfall, had to restrict manuring their fields for fear of "burning" the crop (vigorous growth from the nutrient rich soil could not be sustained by the low rainfall) or "lodging," where very tall stems bend to the ground and curtail yield and harvestability.[429] As such, these farmers relied more heavily on fallowing than fertilization, and more often they employed a 3-5 year rotation cycle,[430] allowing approximately ¼ of their property to fallow at a time. Longer fallow periods, like a bush or forest fallow, make this fraction even smaller. Moreover, those with very small properties could not afford to fallow at all, since every inch required constant cultivation in order to provide a sufficient yearly harvest; on Assiros in the early 20th century "the rich left half their fields fallow every year because they could not sow them all [in autumn-early winter]. The poor sowed nearly all their fields every year, because otherwise they did not have enough to eat."[431] Ultimately, this solution fails to account for low volumes on both fronts; there is little evidence that would suggest doubling the area is appropriate, and even if it were, the parcels were *still* too small.

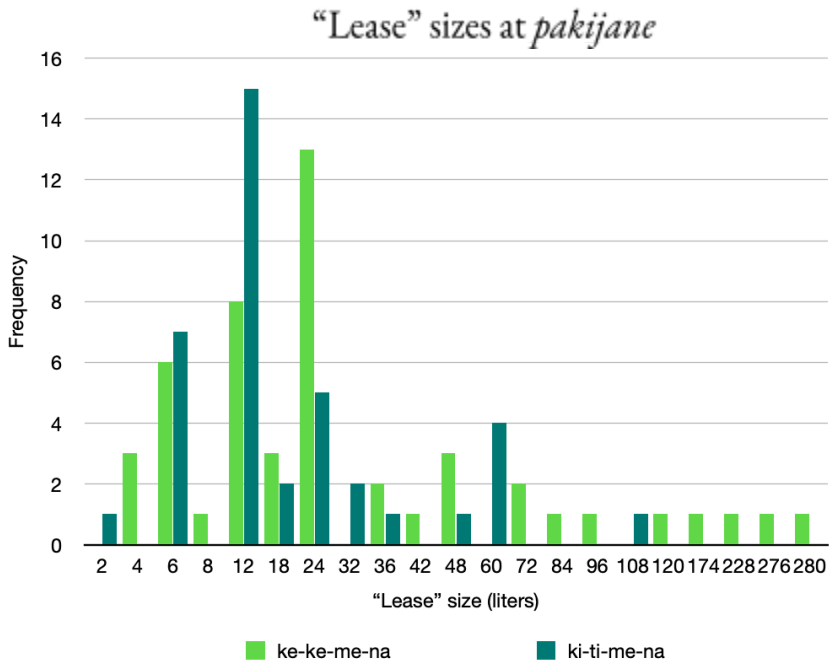


Figure 4.7 Chart showing the frequency of distribution sizes at *pakijane*.

Their second, more enthusiastic suggestion is to adjust required seed volumes for sowing to 50-60 liters per hectare, based on Kassite and Neo-Sumerian analogues. Farming practices in both examples utilized inter-furrow fallowing, and as such the spacing of the sown furrows was 3x what they were elsewhere (0.75 m apart, rather than the 0.2 m Neo-Babylonian and modern Mesopotamean standard).[432] An adjustment such as this would bring the average *ki-ti-me-na* land lease up to ~0.5 ha and the average *ke-ke-me-na* lease up to ~1 ha, 58% and 116% of the requirement for a family's survival, and only in a good year. For community land this appears to resolve the problem. If

[429] Halstead, 2014, pp. 238-239.
[430] Frequently: wheat → barley → oats → 1-2 years fallow (Halstead, 2014, p. 266).
[431] Halstead, 2014, p. 32.
[432] Lewy, 1944, pp. 70-71.

Pylian tenant farmers were practicing this method of cultivation in which they alternate furrow placement within the same plot and till/sow more diffusely, then, on average, recipients of damos land leases would survive. The average, however, conceals inequality in the distribution of these benefits that results in impossible leasing programs. The vast majority of both *ke-ke-me-na* and *ki-ti-me-na* parcels at *pakijane,* for example, were smaller than 30 liters, equivalent to 0.15 - 0.20 hectares *unadjusted* (150 liters/hectare), and 0.6 hectares adjusted to the diffuse Kassite and Neo-Sumerian strategy (50 liters/hectare). At a more granular level, leases from private landowners were mostly 12 liters (*unadjusted*: 0.08 hectares; *adjusted*: 0.24 hectares), and leases from the damos were most frequently 24 liters (*unadjusted*: 0.16 hectares; *adjusted*: 0.48 hectares). A whopping 75 % of community leases and 84% of leases from private landholders **could not have sustained** a single family under the adjusted sowing model. This proportion of unsustainable leases jumps up to 92% (from damos) and 100% (from private landholder) when the sowing strategy is unadjusted.

Additionally, the undulating, rocky topography of western Messenia is distinct from the vast river valleys of Mesopotamia where wide spacing is practiced. Steep ridges and hills wrapped in terraced bands of agricultural land more often accommodate only scattered, short furrows interspersed with rocks and boulders.[433] In this landscape maximizing cultivable areas would have been a vital prerogative, which conflicts with the Kassite and Neo-Sumerian model of farming on sprawling tracts of flat land.

4.2.3 *Sowing Doubt*

Aside from these quantitative issues, the second problem is the plausibility of the standardization of seed volumes. I mentioned at the beginning of this chapter the variation in seed size and appropriate spacing practices during sowing, but it bears repeating here. The appropriate density of seeds during sowing is highly variable: fava beans, *Triticum* wheat, and spelt are sown densely, while chickpeas and einkorn wheat must be dispersed much more sparsely to yield full and healthy crops.[434] The quality of soil also influences sowing practice and ratio of seed volume to hectare, since poorer soils produce less yield. Weed control strategies are largely heterogeneous as well, and as a consequence seed density is impacted. More specifically, in conditions prone to vigorous weed growth (manured fields, older fields, etc.), some farmers elect to sow seeds densely so as to minimize the spaces in which weeds can grow and thus quell competition, while others opt not to risk that the crop grow excessively tall (which can occur when the stands are too dense and the plants compete for light) and subsequently succumb to lodging and choose, rather, to manually weed their sparser stands. These choices can hinge on the availability of labor, the availability of manure and rainfall, the size and distance of their fields (large-scale outfields are the least likely to be weeded), and the preference for or against the consumption of weedy greens.[435]

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[433] Halstead, 2014, pp. 20-21.
[434] Halstead, 2014, p. 28.
[435] Halstead, 2014, pp. 233-238.

	1st Year		2nd Year	3rd Year
	Seed Corn	Harvest (Estimate)	Seed Corn (Estimate)	Seed Corn (Estimate)
barley (ŠE)	900	2100	1300	500
wheat (ZÍZ$^{ḪI.A}$)	300	900	400	[ ]$^{?}$
small emmer$^{?}$ (*šeppit-*)	100	100	50	[ ]$^{?}$
emmer (*KUNAŠU*)	100	100	60	-
karši-grain	70	90	30	-
Rye (ZÍZ$^{ḪI.A}$ KALAG.GA)	-	80	-	-
peas (GÚ.GAL)	-	30	10	-
broad beans (GÚ.GAL.GAL)	-	30	5	-
lentils (GÚ.TUR.TUR)	-	20	10	-

Numbers refer to capacity measures as given in the text (PARĪSU).

Table 4.3 Synthesized (yearly) sowing and harvest grain volumes as prescribed by the governor of the region. (D'Alfonso & Matessi, 2021, table 5.1).[436]

The Hittite records found at Maşat Höyük/Tapikka, HKM 109, demonstrate the irregularity of sowing volumes, even within a prescribed scheme. Here, administrators and agricultural supervisors doled out seed for sowing non-private lands at the frontiers of the kingdom within an ordained 3-year cycle (Table 4.3). These stipulations, as in Pylos, were rendered in (seed) volume measurements, and clearly vary from year to year and cultivar to cultivar.

Finally, heterogeneous sowing techniques also yield different requisite seed volumes. Dibbling, a technique where small holes are filled with seeds, for example, requires the lowest volume of seeds per hectare. This is more common with larger seeded pulses and smaller plots. Broadcasting by hand is the fastest method of sowing, but it uses the greatest volume of seeds for its undertaking and requires a skilled hand in order to broadcast evenly. This is the most common approach and is particularly well suited for smaller seeded pulses and cereals as well as plots inhospitable to the plow. On plots large enough to be tilled by animals, row sowing is preferred. Furrows allow for even distributions of seeds *and* easier weeding.[437] All this is to say that the necessity of crop rotation, the probability of the practice of polyculture, and the variability in plot size, soil quality, and annual rain necessitate plural practices. As such, a standard volume for sowing a field of a given size, while possible in Messenia and attested in Nuzi, is unlikely for the Messenian case.

[436] D'Alfonso & Matessi, 2021.
[437] Halstead, 2014, pp. 28-29.

4.2.4 *Landholder and/or Leaseholder*

Curious, too, is the status of the supposed tenant farmers appearing in the E-series. At the moment of the composition of the Pylian Linear B tablets, we may be seeing a transition from communal property (*ke-ke-me-na* land) to the emancipation of privately held plots (*ki-ti-me-na* land) that followed a parallel transition from non-hierarchical community-level burials to lineage-based, exclusive, and monumental funerary practices.[438] In both cases we see the differentiation of certain individuals, marked out from the community and afforded certain privileges. For private landholders, their higher status is foregrounded by their various titles (*te-re-ta, ko-to-no-oko*) and associations with the *lawagetas* and *wanax*. Among the many shepherds in *ti-no*, the shepherd of the *lawagetas*, *mo-ro-qo-ro*, is a property owner, while many of the others are merely *o-na-to* holders.[439] Whether this privilege was granted by the palace or by some other means, segregating and demarcating land over which one has exclusive use-rights allows that person to have more control over their surplus (profit). In a pre-monetized economy the value of *organic* surplus, the fruits of the land, were first the capacity to ward off starvation and to mitigate other failures in leaner years and, second, the potential conversion of said surplus into social capital. After a period of time even produce with longer shelf-lives, such as cereal grains, begins to rot. Beyond the volume required to sustain a household and sow fields for a single year, maximizing profits in the form of a hoarded grain surplus, year after year, has little intrinsic value. Converted surplus, however, either by way of gift exchange, votives, hosting feasts, funerary display, or acquisition of symbolic resources, supplies an individual/institution the means to engage in social transactions that enhance their esteem.[440]

With this modality in mind, it is surprising to find that nearly 50% of the *te-re-ta* at *pakijane* and over 50% of the other landholders at *pakijane* and *ti-no* were also holders of what earlier scholars identify as leases of *ke-ke-me-na* (damos) land. Some of these so-called leases were as small as 6 liters, or 0.04 hectares. On average the size of these distributions skewed larger than other beneficiaries (106 liters; 0.70 hectares) but did not exceed 2.5 hectares. Ostensibly a leasing agreement would forfeit one's control over some/all of their surplus, and consequently hand off the means of social authority. This restriction is demonstrated in the Mari archives from ca. 1800 BCE, wherein tenants were assigned fields owned by the palace and "had usufruct of the land, [but] he did not have the right of disposal by sale or assignment to another person."[441] This, and the threat of eviction, made the position of beneficiary far less desirable than being the recipient of a royal land grant.[442] Moreover, tenancy, as Warbuton describes, is an affliction of social differentiation and institutionalized inequality, as "peasants were reduced to poverty and debt, the institutions and members of the elite acquired land,

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[438] See the following sample of the prolific Messenian mortuary publications for more information about burial practice and the evidence of social stratification and state formation in the mortuary space: Boyd, 2002; Cavanagh & Mee, 1998; Davis et al., 1997; Galanakis, 2017; Hood, 1960; Lewartowski, 1995; McDonald & Hope Simpson, 1972; Mee & Cavanagh, 1984.

[439] *Po-me , ra-wa-ke-si-jo*; PY Ea 782, 800, 817, and 439.

[440] Voutsaki, 2016.

[441] Batto, 1980, p. 221.

[442] Ibid.

the former owners being thrown into dependency, tenancy, or the labor market."[443] In Classical Athens this was likewise the case; property rights were exclusive to Athenian citizens, and non-citizens (*metics*) were relegated to leasing land as a result. In other words, inequality begets tenancy and dependency, a surprising position in which to find the few who were afforded the privilege of private landholdings.

4.2.5 *Uncertain Interests*

The claim that these documents record lease transactions is difficult to understand from the palace's perspective. The duration and terms of the lease were not registered, so it is unclear what duration of time and what rent exchanged had been agreed upon by the parties. Likewise, as was mentioned above, there are no physical descriptions of the parcels. Uchitel, in his review of 17 land cadastres covering 4,000 years of history in the Near East, notes that the most important detail registered in all of these land documents was the description of the location of each parcel.[444] As a result, if we accept the claim that these are lease agreements, we must also assume that there were *separate* agreements and/or documents in which this information was provided; otherwise the impossibility of upholding boundaries and obligations as well as avoiding disputes among the nearly 100 renters in *pakijane* alone would prove impossible. If we imagine, therefore, that lease agreements existed, but not within the recovered documents from the palace, what is the function of those we *do* possess? Why did the palace need to record that the servant of the god, *e-*65-to*, possessed the usufruct of a 0.01 hectare field in some undetermined place for an undermined length of time at an undetermined cost? Perhaps the palace was interested in tracking the dispersal of land to *e-*65-to* because of his service to the sanctuary, monitoring his subsistence and safekeeping. Yet these documents, as a rule, served a practical purpose within the palatial administration and are not meant to be permanent records for posterity. They were *accounting* records first and foremost, tabulating labor groups, collections and distributions of goods and resources, military deployments, consignments, inventories, and industrial production. They were records of palatial investments and interests. Were there a lease agreement between *mi-ra* and the damos in which she was granted access to 0.08 hectares of communal land, one would presume the rent would be paid *to the damos*, a subordinate but relatively independent institution with respect to the palace,[445] and *e-*65-to* would pay rent *to the landholder*, *ru-*83-o*, not the palace.[446]

In Middle Assyrian land-sale documents, the state serves as a disinterested third party arbiter to property sales between private owners, and it could be argued that the palace at Pylos conferred their authority on transactions of this type (here, leasing rather than purchasing). Several key elements of these Middle Assyrian documents, however, undermine this comparison. First, the state intervened in the composition of a "valid tablet," as was stipulated in a set of sale provisions documents written before the king. Second, they required that, before the sale was final, the property must be measured using the "royal measure," likely at least overseen if not executed by a palace functionary. Third, the

[443] Warburton, 2020, p. 182.
[444] Uchitel, 1998, p. 143.
[445] PY Eb 905 and Ep 613; Lupack, 2008, p. 67.
[446] PY Eo 276 and En 74.

record of the sale, physical dimensions and location of the property, was composed and stored as a legal document that, by its very existence, validated the sale in perpetuity.[447] In the context of the Pylian E-series, not only are we missing vital descriptive components, but the existence of the document itself, and thus by extension the validity of the transaction, was ephemeral. The tablets were not baked and were overwritten when needed. As an impartial arbiter the palace would have failed in *validating* the transaction.

Another approach would be to suppose that grain taxation is the impetus for the palace to compile records of this sort. In fact, in response to the omission of location descriptions–pointed out by Uchitel–Bennett suggests that the E-series tablets ought to be considered "an assessment for the levying of taxes or of services."[448] Through taxation records and the oversight of highly specialized industries, we know that tax in kind was appropriated and then distributed by the palace to craftspeople, labor groups, and other specialists, as well as being used in festivals, feasts, and other gatherings. Rather than redistribution, which has been the recently challenged economic model applied to the Mycenaean palatial economy,[449] the records demonstrate an acquisition and production orientation, as "a range of dispersed raw materials were collated, allocated to specialists, and converted to value-added composite artifacts, ultimately for distribution to a restricted group of privileged recipients."[450] The assortment of commodity-related texts illustrates that the palace was collecting resources that they intended to mobilize in the form of taxation and redistribute as investments in industrial production and gifts.[451] Among these resources were agricultural products, including but not limited to wheat, barley, olives, figs, and grapes for wine. Thus farms were taxed in kind, likely on a village/community level, and then distributed as consignment to named individuals. *Pakijane* and *ti-no* would have been assessed with respect to their yearly or seasonal aggregate produce, and they would have contributed a proportion of that produce to the palace for reallocation and investment. Lupack states, in support of this idea, that "the palace's interest in land derives from its desire to accurately calculate and collect the amount of produce due to it as tax from the landholders."[452]

If we are to accept that the palace generates documents in order to record a) assessments for the purposes of taxation, b) the reallocation of those resources/materials to craftspeople and labor groups, and c) the circulation of the finished, value-added goods, then the profit made from the leasing of land by non-palatial entities (private landowners, damos) is outside of the scope of palatial interests. There are, for example, a variety of documents that index the assessment of village grain, seemingly for the

[447] Postgate, 1971, pp. 512-517.
[448] Bennett, 1956, p. 120; this point (Uchitel)/counterpoint (Bennett) is discussed in Lupack (2008, p. 53).
[449] Advocates for the redistributive model: Finley, 1957; Killen, 2008; Polanyi, 1960; for a more recent challenge to the model see: Christakis, 2011; Lupack, 2011; Nakassis et al., 2011; Schon, 2011.
[450] Halstead, 2011, p. 232.
[451] For a more in depth discussion of how balanced reciprocity was transformed into negative-reciprocal "redistribution" in the palatial period see: Nakassis et al., 2011..
[452] Lupack, 2008, p. 71.

purposes of tax collection. In the document Eq 213 the granaries (*o-ro-jo?*)[453] of various villages were seen (*o-wi-de*; ὦδε ἰδέ " thus he saw") by some sort of assessor when "making a tour of the ploughland," which contained between 720 and 4,800 liters of grain/wheat.[454] Royal and elite grain appraisals appear also in Er 312 as well as in smaller-scale assessments, as we see in Eo 278, where a shepherd named *ti-qa-jo* holds *two* plots, which have generated 996 liters of grain. The formula in these instances is similar to the "leasing" documents, but streamlined, with a notable omission of any reference to holding an *o-na-to* and, in the case of the *lawagetas* and the *wanax*, the addition of a novel land type: *te-me-no*.[455]

PY Er 312

1 *te-me-no* of the *Wanax*
2 so much seed □ 3,600 liters
3 *te-me-no* of the *lawagetas* □ 1,200 liters
4
5 of the *te-re-ta*[ ]so much seed □ 3,600 liters
6 so many *te-re-ta* □ 3
7 wo-ro-ki-jo-ne-jo[456] unencumbered?
8 so much seed □ 720 liters

These properties listed in this account have a privileged, unencumbered appearance, however it is not clear whether the produce gathered from them would have been taxed or not. Elsewhere in the E-series grain stock measurements of large and small volumes of grain were assessed in the Es-series in a similarly laconic fashion; however these tablets have correlated data that trace the process of assessing and taxing wealth. To begin with, the total grain of 13 individuals is counted with the standard formula: (ex. from Es 650) *a-re-ku-tu-ru-wo e-ke to-so-de pe-mo* □ 7. Notably, the assessment is taking place in the month of *ki-ri-ti-jo* "barley month," as is inserted in the first line of Es 647. It is important to note that these, like the rest of the E-series, have conventionally been interpreted as *land* assessments, based on the grain-proxy hypothesis; however the absence of any term relating to parcels *and* the inclusion of the date (especially one related to harvests) bear only a grain volume reading, not a

[453] Perhaps from ὅλος "whole, entire" functioning substantively or, as Palmer suggests "(seed) of barley" from ὄλυρα, οὐλαί, and ὀλοαί. Ventris and Chadwick offer "of the year" from ὥροιο, but ultimately settle on "loss" from οὖλος/ὦλος. This latter reading seems less plausible than the former, which operate in the text as corresponding to a total, stockpile, or granary, because *lacking* and *deficits* are typically expressed by some form of ὀφειλέω.

[454] Translation by Palmer (1963, p. 217); it is still unclear whether this ideogram communicates wheat or grain more generally.

[455] *Te-me-no* τέμενος survived in historical Greek and carried the sense of land set aside for kings and chiefs as well as sacred land, often dedicated to a god and administered by a temple. The sense of the former, which appeared in Homer, aligns with its meaning in the tablets, as it appears only with reference to *wanax* and *lawagetas* property.

[456] Unknown word; Caratelli (1954) and Ventris and Chadwick (1973) understand this word as a version of Ὀργεῶνες "members of a religious association" and also related to ὀργάς "rich land or sacred grove." In combination with *e-re-mo* from ἐρῆμος "desolate, lonely, solitary" the sacred grove/land suggestion appears more plausible. Moreover, Ventris and Chadwick (1973) read *e-re-mo* to mean in this context "land left inviolate, free of annexation or encumbrance." Another possibility is that the word is related possibly from ὀργάω "ripen," which could refer to a cultivated fallow (a very common practice), or ὀργιάζω "celebrate, pay ritual service," which appears with the subject τελεστής (te-re-ta) in Plato, *Phaedrus* 250.b-c.

land proxy reading. These same 13 people are listed in a set of documents that feature a distinctive term, *do-so-mo*, which is equivalent to δόσις "offering, contribution, thing to be given." These payments are of two kinds: year-over-year (*we-te-i-we-te-i* cf. ἀμφιετεί) and to Poseidon and unknown lesser gods (**34-ke-te-si, we-da-ne-wo, and di-wi-je-we*). The assessment, therefore, was followed by the tabulation of yearly tribute paid to the palace and to various gods/sanctuaries.

PY Es 650

1	in the barley month , *ko-pe-re-u*	has so much seed	□ 720 liters	
2	*a-re-ku-tu-ru-wo*	has so much seed	□ 840 liters	ASSESSMENT
3	*se-no*	has so much seed	□ 120 liters	

+10 lines...

PY Es 644

1	*ko-pe-re-wo* yearly contribution	□ 72 liters	
2	*a-re-ku-tu-ru-wo-no* contribution	□ 114 liters	TAXATION
3	*ṣẹ-no* yearly contribution	□ 24 liters	

+ 10 lines...

PY Es 646

1	*ko-pe-re-u:* contribution to Poseidon	□ 180 liters	
2	contribution to **34-ke-te-si*	□ 20 liters	OFFERINGS
3	contribution to *we-da-ne-we*	□ 20 liters	
4	contribution to *di-wi-je-we*	□ 20 liters	

After the assessment and collection of taxed grain, the second of two procedures, its reallocation and investment, is somewhat visible. Is evident from the rations and disbursements that the palace accumulated other resources for industrial production, religious gifts, and the support for labor groups and craftspeople. Following the acquisition of staples and more exotic raw materials (the latter more likely obtained by trade or other means), the palace distributed materials and rations to specialized labor groups. The Jn-series, along with its community level bronze assessments, also documents the apparent allocations of bronze (and occasionally gold) to individual named smiths in

various towns.[457] Chariots and accompanying leather gear seem to have been produced off-site from raw material consignments (possibly in *ti-no*, based on the concentration of specialized craftspeople) and stored in the palatial complex when finished.[458] Textiles and perfumed oils were also particularly important industries and were located primarily in the palace workshops. Some craftspeople and individuals of unknown vocations received small amounts (4-8 liters) of barley rations as well as olives, and religious personnel and gods were given larger quantities of barley and figs (always in equal measure per allocation). Larger volumes of rations feature wheat, figs, and olives. In one case *ko-ka-ro*, an unguent boiler, was rationed 120 liters of wheat and figs (PY Fg 374), a weaver received 1,440 liters of wheat, and a net maker received 240 liters of both wheat and figs, to name a few (Un 1322). Other craftspeople received both consignments *and* rations/compensation of larger volumes. An individual on Un 443 received 120 liters of wheat and 5 units of wool.

Finally, some of the finished products, value-added composite artifacts such as textiles and perfumed oil, were gifted to members of the elite, townspeople of *pakijane*, deities, and individuals with special interests, such as the Sa tablets that assigned pairs of finished chariot wheels to *e-qe-si-ja* "followers" (chariot riders).[459] With the exception of the latter category of recipient, whose assignment of finished products was practical, these manufactured gifts "were not merely valued objects but prestige goods playing an active role in the affirmation and negotiation of status."[460]

Rent collected within the leasing paradigm, however, has an uncertain place in this system. Cultivated community land likely would have been assessed by its overall output, regardless of whether the farmers were renters or members of the community with access to it. The rent paid to the damos, for example, would simply constitute a portion of the whole taxable quantity. In other words, from the perspective of the palace it is irrelevant *how* the granary was filled, whether by rent, local tax, or entirely pooled resources. If this is the case, how do these leasing documents fit in the paired assessment-investment recording convention? When the palace composes records that assess volumes of grain and those that register the distribution of the acquired surplus (taxes), and if separate lease agreements with pertinent location, duration, and price information existed, either in writing or otherwise, what value exists in generating scores of E-series tablets, including first and second drafts, that catalog information irrelevant to assessment, investment, or leasing terms?

4.2.6 *Leasing Schemes in the Near East and Anatolia: A brief survey*

Based on administrative documents from elsewhere in the Mediterranean and Near East, evidence for (i.e. documentation of) leasing land in the Bronze Age is rare. From the archives in Mari, three categories of land have been discerned: private lands with full inheritance rights and alienability, tribal lands held by an ethnic community, and crown lands owned by the palace. As was mentioned above, crown lands were either worked directly by the palatial labor force, or "farmed out to palace

[457] Standard header: [Place name] *ka-ke-we ta-ra-si-ja e-ko-te* (χαλχῆϝες ταλανσίαν ἔχοντες); body (list): [smith name] BRONZE + amount.
[458] Bendall, 2003.
[459] Schon, 2011, p. 222.
[460] Halstead, 1999.

dependents as a kind of indirect rationing."[461] The status of the individual determined their receipt of either rations from the palatial supply, tenant farming on crown land, or gifts of land grants. The latter two categories, those reduced to tenancy and those with full ownership rights, seem to have been in like manner taxed in kind, the "rent" from the tenant indistinguishable from the tax paid by the landowner. Profit-making within the palace was consequently uniform, while this same revenue was not available or at least exercised by other landholding parties; parceling out fields for the sake of profiting from rent among non-palatial parties is a practice absent from the archives, however, there is of course room for this *existing* without being a concern for palatial administrators.[462]

The conventional interpretation of the land categories within the Middle Assyrian system is that there are three categories: private property, crown lands, and palace land "leased" to a tenant.[463] Once again, the practice and/or the formal documentation of these lease agreements were the reserve of the royal administration, and such revenue was either not sought by or forbidden to private landowners. Even these state sanctioned "leases," however, have recently been reconsidered, as Postgate argues convincingly that in cases where property rights are revoked and reallocated to another person, rather than the "lease" being transferred, the property is in fact released to the state (then another individual) upon their death.[464] A similar system was in place in Nuzi, however in this instance, tenancy of royal lands could be inherited *after* the parcel was officially returned to the state.[465]

The Hittite Kingdom has afforded an abundance of legislative and cadastral documents that illuminate land rights and obligations. While references to various categories of landholders are gathered obliquely through laws pertaining to the acquisition of land with an attached obligation, we know that obligations tethered to individuals were transferred to their parcels of land after their death. These obligations and services are variously titled GIŠTUKUL, *saḫḫan/luzzi-*, and ILKU, however the exact terms of such assignments are unclear. They seem to straddle both military services and harvest taxes, and it has been suggested that *luzzi* was a harvest tax imposed on private, family-owned plots, with *saḫḫan* being a tax exacted from privately held plots gifted by the state. The GIŠTUKUL obligation, however, was corvee labor owed to the state, and ILKU was a rent obligation on a parcel of land allotted to state dependents *from* royal landholdings.[466] The former category appears in the text with the Akkadogram (*ILKU*) and appears to borrow or share both the term *and* the practice with the Old Babylonian system mentioned above. Rent from leased lands, therefore, moved exclusively toward the palace and was exacted in order to sustain other sectors of the population via redistribution.

In all of the above mentioned examples, the privileges of private land ownership range from ownership with obligations (tax, services), ownership without obligations (tax exemptions), and rights to inheritance and alienability, yet they never extend to revenue streams from collected rent. Holders of neither village land nor private land engage in leasing transactions where the profit is transferred to anyone other than the palace/state, and as such we can deduce either that this was the state's exclusive

[461] Batto, 1980, p. 212.
[462] Batto, 1980, pp.210-232
[463] Garelli, 1967.
[464] Postgate, 1971, p. 412.
[465] Lewy, 1942, pp. 15-18.
[466] Marazzi, 2008; D'Alfonso & Matessi, 2021.

right, or the agreements among extra-palatial parties were ignored by palatial administrators. Either way, these analogues diverge from the leasing paradigm proposed for the E-series.

4.3 **Reconsidering the *o-na-to* and Redistribution**

Were one or two of these paradigmatic conflicts present in Pylian "leasing" documents, it would prompt further consideration and reassessment. If the parcel size, for example, were the only snag, we would perhaps be compelled to reexamine the unit:liter relationship, favoring a larger volume measurement, or if the only concern were the transgression of private ownership privileges in the instances where landholders are also lessees, then we might consider folding plot-type diversity into the paradigm, wherein renting a wheat field might complement large privately held orchards, but it is the aggregate of these inconsistencies that leaves the leasing paradigm on the wrong side of Occam's razor. What is needed is a solution that requires *ad hoc* assumptions that rectify a) the historical rarity and practical difficulty of grain volume-to-area measurement proxies; b) the heterogeneity of sowing practices and seed volume requirements; c) the miniscule parcel size unsuitable for a family's subsistence; d) the counter-intuitive landholder-as-renter arrangement; e) the paucity of information pertinent to a lease agreements in the formulae; f) the uncertain place these documents held in the assessment-investment taxation system evident in other Pylian administrative documents; and g) the propensity for the palace/state to withhold the right to collect rent on leased lands from private and communal landholders in other Bronze Age societies. Yet such a solution is epistemically messy. All of these exceptions, caveats, and complications are tethered to the first, fundamental assumption: what is measured on the documents is an abstraction–the grain is not grain, but land.

4.3.1 *Parsimony and the Nature of the Benefit*

If we were to simplify and take the documents at face value, it would be clear that whatever "benefit" was doled out *derived* from a landholding, private or communal, and was composed of agricultural produce (perhaps wheat, but more likely grain/seeds more generally) and dispensed by landholders to individuals who worked in service of the community, palace, and/or sanctuary.[467] The palace appears to have been overseeing the distribution, if not fully forcing and enforcing it, and the name and occupation of the recipient, benefactor, and volume of the distribution was their prime interest. In their most neutral state, the documents seem to be recording local administration of redistribution and, perhaps, rations. In this instance, rather than the produce being conveyed from *pakijane* and *ti-no* to the palace on Ano Englianos, only to be disbursed to the craftspeople,

[467] Uchitel makes an important contribution with respect to the *pa-ro X* phrase, suggesting that the force of the preposition πάρο + dative has the force "at the disposal of" or "under the control of," rather than "from." This accords with the idea that the "benefit" derived from land belonging to an individual/institution who ultimately had the control over its disposal, though Uchitel ultimately argues a different reading from my own, that the E-series is comparable to the Hittite royal land. (Uchitel, 2005, pp. 477-478).

herdspeople, and sanctuary personnel in the place of its origin, the produce is distributed to palace dependants *by the cultivators themselves*. This method of redistribution is attested elsewhere during the Bronze Age; in Middle Assyrian texts the *ilku ša ālāiūti* "ILKU-obligation of villager dependent" was a state-imposed service transaction by which private landowners had dependents who had some form of service-obligation to the landholder or the state.[468]

In an astonishingly similar Hittite parallel, "state-cult" festivals, which were particularly important because of their dedication to the primary gods of the Hittite pantheon and the personal participation of the king (*cf.* the special status of the sanctuary at *pakijane* and its relationship to the *wanax*), took place in villages that provided both cult offerings *and* food-gifts (MELQĒTU) "as viatica for teams of priests, performers, and cultic participants during the weeks-long celebration of the festivals."[469] These food-gifts were composed of bread loaves and beer, and were recorded separately from festival descriptions and without any reference to their proceedings:[470]

III 22'–31'

22' The *zinḫuri*-men take [1 k]id (and) 1 large ordinary bread

23' [i]n the temple of the god Inar.

24' [20?]*ḫališ*-[bread loaves] of 20 (shekels each), 2 *wageššar*-bread loaves of 15 (shekels each),

25' [2? containers of *m*]*arnuwan*-beer the AGRIG of the town of Alisa

26' gives [to the] *zinḫuri*-[m]en

27' [1 sheep 20 *ḫa*]*liš*-[bread loaves] of 20 (shekels each), 2 *wageššar*-bread loaves of 15 (shekels each)

28' [2 containers of *marnuwa*]*n*-beer (and) 15 *šarama*-bread loaves

29' [the AGRIG of the town of K]arahna

30' [gives to the *z*]*inḫuri*-[men]

31' [They take their seat, they e]at and drink.

(From D'Alfonso & Matessi, 2021, whose translation was based on Singer, 1984, pp. 106-7)

Folded into more generic Hittite festivals were redistributive practices as well, as communal storage jars were ritually filled during harvest time and emptied (and consumed) at sowing season.[471] As opposed to rations, which *sustain* a workforce, these dispensations were religious in nature and *rewarded* the requisite effort, time, and expertise of festival participation. Given the volume of religious titles of grain recipients in the E-series, it appears to have more in common with this Hittite text than, say, a leasing log.

4.3.2 *The Mechanics of Local Redistribution*

Aside from Near Eastern comparisons, the argument for community-level redistribution in the Pylian Kingdom is particularly credible based on the archaeological evidence from the central palatial

[468] Postgate, 1971, pp. 496-499.
[469] D'Alfonso & Matessi, 2021, pp. 145-147; Singer, 1984.
[470] D'Alfonso & Matessi, 2021, pp. 146.
[471] Ibid.

complex (and those elsewhere on the Mainland). A large proportion of the square footage of the Palace complex in Pylos was dedicated to industrial enterprises. Textile production appears to have been concentrated in the rooms directly above the megaron and in the SW area, wine was stored and/or processed in the wine magazine in the north, a kiln for pottery production sits to the north of the complex, and the oil magazine just north of the megaron was discovered alongside documents pertaining to the production of perfumed oil. Storage was also accommodated in the palace complex; thousands of ceramic vessels were excavated in rooms 18-22, adjacent to the megaron, the archives complex housed the bulk of the Linear B documents (where they were also likely prepared/copied), and the North East Building (NEB) functioned as a clearing house for redistribution and short-term storage of textiles, wheels, harnesses, foodstuffs, skins, wine, bedding, and weapons, among other things.[472]

Strikingly, what is absent or heretofore unidentified is any evidence of grain storage on a scale commensurate with the subsistence requirements of palace dependents. For context, the accumulation of staples in the Hittite kingdom was facilitated by extraction and storage infrastructure at various levels. Storehouses in various villages existed in a network administered by state officials at which seeds for sowing were amassed through taxation.[473] Storage structures and silo pits have been discovered in Hatussa and Büyükkaya, and massive underground granaries were installed in Hatussa, Kaman-Kalehöyük, and Sarissa, which could store between 400 and 4,200 tons of grain each.[474] The scale of these granaries are unparalleled elsewhere in the ancient Mediterranean, and they each could sustain between 4,000 and 23,000 individuals year round.[475] This, of course, is beyond the requisite capacity for Bronze Age Pylian dependents (and indeed beyond the requirements for the Hittite population), but this example serves to underline the archaeological visibility of the investments in grain storage; as Christakis notes, "although there are many and varied storage vessels, which often leave no traces, particularly when made of perishable materials, the storage of large quantities of goods for long term, as we can see from a multitude of ethnographic parallels, requires exclusively ceramic vessels and built storage facilities."[476]

In a somewhat more comparable scenario, the Minoans on Crete also left traces of their storage installations, though they were much more humble than those of the Hittites. At Knossos, the palatial storage facilities boasted a high volume of large pithoi with the potential to be stocked with as much as 300,376 liters of grain altogether.[477] While this was not enough to sustain the entire population of Knossos, an estimated 15,000 individuals, it certainly could have been distributed to palace dependents, a subset of the overall population. The palaces at Phaistos and Knossos also host a suite of so-called *koulares*, large underground stone-lined structures that have been interpreted as granaries, though this has been debated, and Malia had a silo-complex.[478] Ayia Triada in the Mesara Plain was

[472] Bendall, 2003.
[473] D'Alfonso & Matessi, 2021, pp.136-151.
[474] Ibid.
[475] Fairbairn & Omura, 2005.
[476] Christakis, 2011, p. 203.
[477] Christakis, 2011, p. 202.
[478] Privitera, 2014.

home to 90 large storage jars within an architectural complex called the Villa Reale, an estimated 41% of whose square footage being dedicated to the storage of 30,000-33,000 liters of goods. Also at Ayia Triada was the *Bastione*, a ~16m x 10m freestanding building accessible only from above through trapdoors, whose contents were almost certainly agricultural produce. The storage capacity of the *Bastione* was approximately 140,000-150,000 liters and would have accommodated the volumes of staples of a similar magnitude registered on the Linear A documents found at the site.[479] Despite the fact that these storage facilities fell out of use when the economy shifted from staple to wealth finance, they remain archaeologically visible, a feature dissonant with the Pylian evidence.[480]

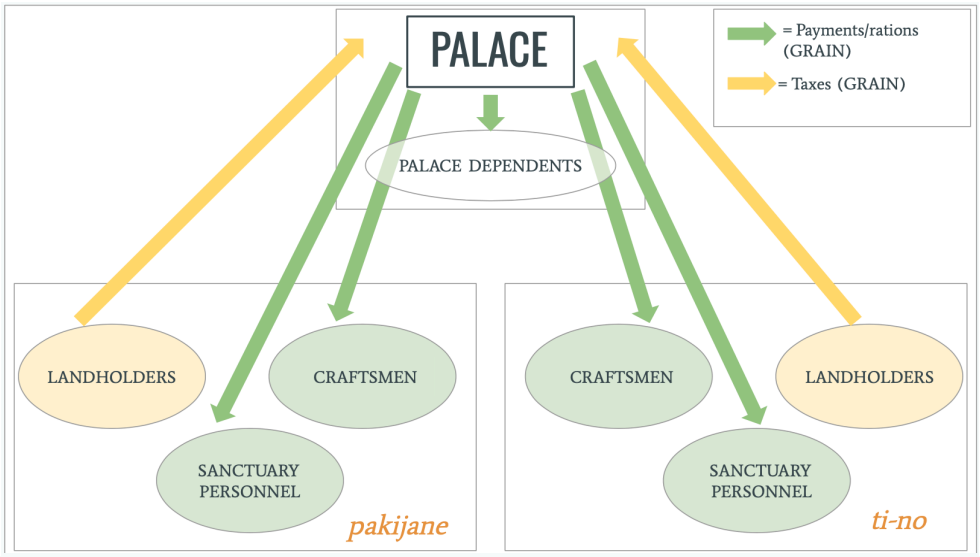


Figure 4.8a Schematic of the flow of resources in a traditional redistributive program. Taxed grain moves from the village landholders (private and communal) and stored in the palace. The palace then redistributes this wealth to both palace dependents (at Pylos) and contracted craftsmen and sanctuary personnel (at *pakijane* and *ti-no*).

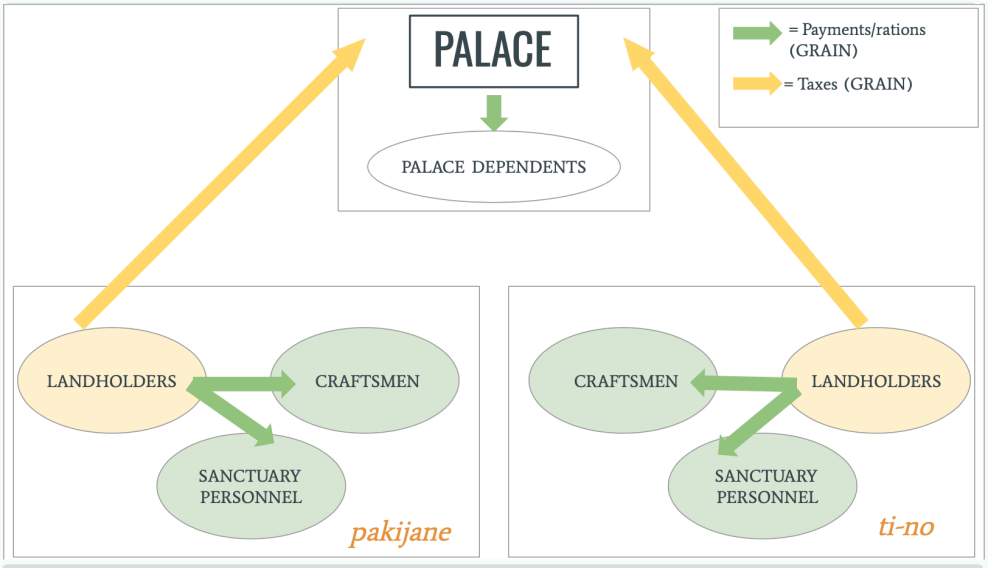


Figure 4.8b Schematic of the flow of resources in a local redistributive program. Some taxed grain moves from the village landholders (private and communal) and is stored in the palace. The palace then redistributes this wealth to palace dependents (at Pylos). Other grain is distributed directly to contracted craftsmen and sanctuary personnel (at *pakijane* and *ti-no*).

Given these limitations, it is not inconceivable that palace dependents and/or independent craftspeople stationed *outside* the palatial complex would have been supplied with staples (either as

[479] On wealth finance: Privitera, 2014, pp. 436-438.
[480] Halstead, 2011.

compensation for their work or their subsistence altogether) derived from *locally* pooled resources. Where place names are mentioned in combination with rations (Ab-series), 25 out of 28 (89%) record distributions of grain and figs to work groups *at Pylos*.[481] The remaining three disbursements occur in three separate locations. The aggregate picture is one highly centered on ration distributions in and around the palace. Rations of barley and figs/olives were disbursed to named individuals, as opposed to work groups, in the Fn-series but lack topographic cues.

It is difficult to estimate the size of the dependent population in LH IIIB, when the records were composed, but it is clear that many were located outside of Ano Englianos in general, and in *ti-no* and *pakijane* specifically. The E-series has revealed that there are at least 71 individuals with special occupations at *pakijane* and 21 at *ti-no*. At *ti-no* in particular, those mentioned cluster around herding and craft production fields that were of specific interest to the palace. In sum, the absence of large-scale food storage on-site at the palace combined with the abundance of palace-affiliated professionals in the towns mentioned in the E-series suggests that *local* redistribution was taking place. Rather than collecting and storing grain in the palace only to then dole it out to dependents or contracted specialists in nearby towns, it's possible that the circulation of grain payments occurred entirely outside of the palace confines. If this were the case, taxed grain derived from the damos or a private landowner at *pakijane* would move directly to a payment recipient in *pakijane*, thus sparing the palace the cost of setting up shipping and on-site storage infrastructure.

4.3.3 *Heterogeneous Dependency and Labor*

Labor extraction in the Pylian Kingdom was a multiplex and highly regulated. At the time of the destruction of the palace, thousands of individuals whose labor was allocated to state-wide projects were being tracked and distributed to loci of construction, defense, and industry. The A-series logs work groups composed of women and children and, separately, men. The tasks of the former tend overall to pertain to linen and textile production, as well as "bath attendants" and "grain measurers", while the latter groups had military duties as well as shepherding, potting, bowyering, goldsmithing, sewing, and building assignments. From the records it seems rather large work groups were assigned to *ti-no* (90 men to work as cowherds) and *pakijane* (254+ men to work as craftsmen), the largest labor groups assigned in the kingdom. The conscription of such a large labor force was accomplished by varying means, and, as a consequence, their level of dependency would have likewise been heterogeneous.

At one end of the spectrum were the fully dependent work force of the enslaved and permanently employed laborers. Nakassis estimates 140 individuals identified explicitly as enslaved,[482] with an additional 1,654 women and children stationed primarily in Pylos but also elsewhere in the kingdom who were presumably fully dependent on the palace and its regional networks for their subsistence. For the most part they were tallied, unnamed, based on their occupations; for example in

[481] There are many individuals and work groups mentioned in the A-series and others, especially wool and linen specialists, who are stationed in other places in the kingdom, however those records that specifically tally rations allocated to workers reveal a concentration of rations disbursements *in Pylos*.

[482] Nakassis, 2021, p. 98.

Ab 578 seven women, four girls, and four boys were registered as "wool carders" at Pylos and received rations comparable to the size of the labor group. In other instances, the group was identified ethnically, as is the case with the Limnians, Knidians, Lydians, Milesians, and others.[483] It is possible that these groups were captured from those places, or perhaps immigrated and found permanent work in the employ of the palace. The occupations "wage-earners" and "captives" in several of these documents make either or both scenarios plausible.[484] As was mentioned above, rations of grain and figs were disbursed primarily at Pylos and on a monthly basis.

Temporary or conditionally dependent work forces composed of men conscripted from various regions of the kingdom were an instrument of the taxation system, as both human and agricultural resources were extracted from communities and moved into the palatial industrial complex. Lists of villages in the kingdom are paired with a tally of men, seemingly recording a delivery of corvee laborers.

PY An 207

...

6 *re-ka-ta-ne* (place name), riveters □ 2

7 *ṛẹ-ka-ta-ne* (place name), potters □ 2

8 *re-ka-ta-ne* (place name), temple servants? □ 12

4

9 *wa-a2-te-we* (place name, locative), pourers? □ 10

10 *a-nu-wa* (place name), goldsmiths □ 4

11 (place name), superintendents of honey? □ 2

12 (place name), bowyers □ 5

13 *a-pi-no-e-wi-jo*[485] (place name) □ 1

14 *so-ro-pe-o* (place name), stitcher □ 3

15 *ko-ri-si-jo* (place name), stitcher □ ?

16 *ka-ro-ke-e* (place name, locative), stitcher □ ?

17 *ra-ni-jo-ne* (place name), stitcher □ ?

18 (place name), stitcher □ 20

PY An(6) 35

1 masons who are to build

2 *Pylos* □ 2 towards *me-te-to* □ 3

3 towards *sa-ma-ra* □ 3 towards *Leuktron* □

…+ 3 lines –

PY Ac 1278

me-ta-pa (place name) □ 22 owed □ 7

PY Ac 1277

a-ke-re-wa (place name) □ 10 owed □ 6

PY Ac 1275

pe-ti-ni-jo (place name) □ 25 owed □ 1

There are additionally eight documents that tally of men owed (o-pe-ro ὀφείλω) appears with each single entry tablet. This designates either an account of a partial default on the labor obligation by the town or a partial exemption. It is not known what metric determines the quantity of corvee laborers

[483] Ab 186, Ab 189, Ab 515, and Ab 573, respectively.

[484] Ab 563 and Ab 586, respectively.

[485] Being in the genitive, this name and that in lines 15 have been traditionally understood as ethnics, however the context of the document makes this interpretation questionable. Another, more applicable solution can be drawn from PY An(5) 424, which, in place of a toponym, reads *ke-ra-ti-jo-jo wo-wo*, the boundaries (territory) of *ke-ra-ti-jo* (personal name). Perhaps what is missing in the above entries is the word *wo-wo* (ὅρος "boundary).

the communities were obliged to send, but it may be related to population size or obligations attached to private landholdings. In fact the unknown service to the palace that the *te-re-ta* provided may in fact have been connected to this recruitment enterprise; however, Nakassis warns against the flattening of these processes, leaving open the possibility that plural extractive techniques may have existed concurrently.[486] The conscripted individuals are assigned tasks and stationed either at Pylos or in other parts of the territory for a period of time. Having been separated from their communities and sources of subsistence for the duration of their labor term, these workers would have been fully, if temporarily, dependent on the palace and its local redistributive networks for their provisions. In fact, many of the occupations listed in the personnel tablets overlap with those who received barley disbursements in the Fn-series, which range from 2 days to 3 months worth of food. Since the labor period of each of these payments was not mentioned, it is not clear whether larger barley payments were attributable to the time spent on *or* the variable value of the tasks undertaken.

At the far end of the spectrum of dependency, where compensation for goods/services was high and dependency was low, we see independent specialists operating in extra-palatial markets. The transactions between such people and the palace was an inversion of the abovementioned enterprises, wherein the *specialist* was the producer, and the palace was the consumer.[487] Ceramic production, for example, was an industry that seemed to have operated outside of palatial supervision, evidenced by the dearth of tablets associated with it and the scarcity of archaeological evidence for its in-house production in the palace at Pylos. The palace was, however, a consumer of pottery on an ad hoc basis, boasting approximately 12,000 vessels. The fabric types present in the palace's pantry and the number of potters mentioned in the documents suggest that there were four potters within the palace's orbit. While the volume of stored vessels strongly suggests that the palace was a major consumer of pottery, their production would not have required full-time allocated labor. Not only were the vessels reused and likely only replaced when broken (especially infrequently in the case of the 140 pithoi, which required the greatest time and resource input but would have seldom needed replacement), but the collection of largely undecorated vessels would not have required the extended full time labor of four workshops.[488] Much like Petsas House in Mycenae, these production centers would have been hubs of private commerce within local and possibly international markets.[489]

Compensation for specialized contract work went beyond a ration-wage, as gifts, tax exemptions, and even land allotments were dispatched by the palace. Commodities or goods were exchanged for other commodities in an *o-no* (also from ὀνίνημι) transaction, and perfumed oil and other finished prestige goods were "distributed by exchange" (gift exchange or *o-no* transactions).[490] Others, such as the bronze smiths, were recipients of flax (or its by-products) tax exemptions on their

[486] Nakassis, 2021, p. 99.

[487] Shelmerdine, 2011, p. 24; ceramic production is interrogated here, but bronze smithing also seems to have functioned similarly. Contracts with the palace were subsidized by allocations of bronze in the *ta-ra-si-ja* system (an amount of raw material is measured and doled out and processed into goods), but this work was part time and would not have occupied them for the majority of the year. See: Nakassis (2015) and Shelmerdine (2011) for a fuller discussion.

[488] Hruby, 2013, p. 425.

[489] Shelton, 2010; Shelton, 2016.

[490] Halstead, 1999, pp. 39 and 41.

landholdings, possibly in exchange for their contract labor on behalf of the palace.[491] Finally, in the Ea-series that records the distribution of benefits from landholding in *ti-no*, it is clear that privileged individuals were granted parcels of private property, a likely remuneration for some services. The landholder *mo-ro-qo-ro*, for example, was given the moniker "shepherd of the *lawagetas*," *e-u-me-de* was a perfume boiler, and *sa-ke-re-u* was a priest and a bronze smith. At *pakijane pi-ri-ta-wo* was the "potter of the *wanax*," *a-ka-ta-jo* was a fuller, and *po-te-u* was a swineherd. Additionally, between both communities, there are five individuals who also appear in the Jn-series as named bronze smiths.

4.3.4 *Benefits and Burdens of Private Ownership: The liturgical paradigm*

The exchange of corvee labor for land-tenure privileges is a contract very well attested in Middle Assyrian, Nuzian, and Hittite archival documents, where we see the shared term *ILKU* applied to real property. The obligation was that of military service, labor for the palace, or, in some cases, a payment in silver *in lieu* of months-to-years long work assignment. The link between land-tenure rights and services to the palace was evidently standard, and the commutation of the physical work obligation was fossilized in medieval European tenure strategies in the form of "rent" payments to the "lord."[492] Were this policy implemented in the Pylian polity, as it appears to have been, *pi-ri-ta-wo*, the potter of the *wanax*, would be called upon to provide vessels for the palace intermittently in exchange for his continued tenure rights, or he would be permitted to commute his labor obligation in the form of a payment. It was also not uncommon for landholders in Shuruppak to receive rations or a one-time payment of barley *in addition to* their tenure privileges as a result of some service provided.[493]

With these analogues in mind, let us return to the E-series and its landholders. If we accept that the *damos* and private individuals were doling out grain allocations from their accumulated stores and that the source of this distribution was their property (as is indicated in every entry with the term *ko-to-na* and its qualifier), then it is plausible that we have been granted a glimpse at the attached obligations of land-tenureship. Whether or not these distributions are a component of the corvee obligation (payment instead of labor) or an additional obligation, formal or informal, it seems the palace was acutely concerned with the extraction of grain (average = 19% of their total stock) from landholders and its reallocation to 61 religious functionaries, 12 craftspeople, 7 herdsmen, and others. Rather than supplying an amount of grain back to the palace, where it would be stored and subsequently mobilized as payment to industrial or religious personnel, it was extracted and immediately redeployed to payment recipients within the same town (here, *pakijane* and *ti-no*). What, then, was the nature of the beneficiaries' work, for how long were they supplied grain, and why were the rations/payments registered differently from the others?

To begin with, the size of the distributions, most frequently 12-24 liters, signals a limited temporal scope for the compensated labor. With respect to the majority of the beneficiaries, comparable volumes of grain are evident in Fn 324, a list of barley rations disbursed to various men

[491] These exemptions appear in the Na-series, which appears to be an assessment/collection of flax farms; Nakassis, 2015, p. 598.
[492] Cripps, 2007.
[493] Cripps, 2007, pp. 84-97.

(several of whom appear elsewhere on documents related to animal flocks). Were they subsistence rations, they would, for the majority of the recipients, supply a roughly 2-4 week labor period. Unlike Fn 324, however, the array of sizes is much more heterogeneous. While the volume *most often* calculated on the documents is indeed within the above mentioned 12-24 liter range, they can also be as small as 2 liters and as large as 552 liters. As gifts, on the other hand, this heterogeneity could reflect a shorter period of service, wherein the nature of the services rendered varied along with their perceived value. The latter hypothesis, gifts for diverse services, is supported if we return to Table 4.4 on page 125, where the average distribution size is calculated based on occupation. The priests at *pakijane* received on average 183 liters of grain, while the male servants of the god received just 13 liters. Subsistence rations over the course of variable service periods may be plausible, but this gulf between the distribution volumes maps easily onto the assumed status gulf between these two occupations. The job of the priest during a given period was thus of higher value than that of the servant of the god, and their compensation reflects that. While the duration of the services/labor is not clear, I posit that it is shorter term and would not require the separation of the participants from their sources of sustenance for any prolonged period, perhaps one week.

The nature of the work of the beneficiaries was mostly religious (71+/114 of the preserved occupational entries: 62%).[494] In fact, the sheer number of servants of the god as well as the other religious functionaries seems staggeringly high. It is possible that these individuals, particularly the servants of the god, worked full-time in the service of the sanctuary, possibly fully dependent agricultural laborers on land not registered in the palatial documents. This is precedented in many other places at many other times and is a great source of wealth for a temple and/or sanctuary. Yet this land and its administration is absent from the palace's records, and thus the subsistence of the sanctuary's dependents would have been the ward of an institution separate from the palace (the damos, the sanctuary?). As such, it is unlikely that they would have received small disbursements of grain supplied by outside landholders. More believable is the possibility that their work was periodic and in accordance with the festival calendar of the sanctuary at *pakijane*, and possibly elsewhere. If this was the case, then the temporal scope of their services would have been harmonious with the term mentioned above. Perhaps citizens of *pakijane*, otherwise employed in farming communal land, would have prepared for and participated in the rituals of the festival, a common occurrence in the Greek festivals of the historical period.[495] The tablets list, for example, a servant of the god named *du-ni-jo*, whose name appears in 11 other documents, providing wine, livestock, olives, and grain to Pylos for a feast, holding the title of *du-ma*, providing or receiving men for military or corvee service, and receiving barley rations, among other things.[496] These overlapping obligations and commitments demonstrate that the servants of the gods were engaged in the community and economy beyond what would be

[494] The number of "barleyers," a group of religious functionaries, is unknown. Since there is certainly more than one (the verb is plural), I have assigned the number as 3, a conservative estimate, and added the sign "+" to signal that there were likely more.

[495] See Burkert, 1985.

[496] Ae(1) 8, Ae(1) 72, Ae(1) 264, An(7) 192, Ea 59, Ea 811, Eb 169, Ep 705, Fn(1) 79, On 300, Un(3) 138; Nakassis has argued that this compilation constitutes at least 2 men with the same name but finds connections between several of the documents that demonstrate overlapping duties in service of the palace (Nakassis, 2012, pp. 237-239).

expected for a full-time agricultural laborer and would have likely performed their servitude to the deity only within a prescribed period of time: a festival, perhaps.[497] This transitory appointment would also accord with the detailed quality of the entries, wherein "servants [of the god]" are individually named, rather than coordinated as a labor group as they are in the A-series.

While cautiously avoiding overburdening a tenuous hypothesis, it may be possible to understand the role of the "secular" beneficiaries through this lens as well. It can be assumed that a cook, herdsmen, and potters would be employed in a feasting event, furnishing the vessels and fattened animals, and preparing foodstuffs for the function.[498] The fullers and (leather?) garment-worker may have prepared ceremonial robes or textiles, and a bronzesmith may have equipped the σφαγίς "sacrificial knife" and metal vessels. The wheelwrights and *ke-re-te-u* (who received 600 liters of grain "on behalf of the horses" in Ea 59) bestowed a drawn chariot for the *pompe*.[499] A perfume boiler may have brought offerings to the god, and the beekeeper provisions the honey for, perhaps, the *me-ri-du/a-ma-te*.[500]

To resolve the final, most important question about the difference between the documents' format/contents and those registering rations/payments, it is imperative that we contextualize the obligations attached to landedness within the larger systems of reciprocity during the Bronze Age. In their 2016 discussion of reciprocity in the Aegean Bronze Age, Galaty, Nakassis, and Parkinson engage with decades of the sociological and economic anthropological discourse surrounding reciprocal exchange as the cornerstone of economic and social organization and apply it to the shifting social landscapes of Mycenaean communities.[501] Here, they explore the imbricated systems of kinship and obligation that structured social networks prior to the advent of the Mycenaean state and were subsequently co-opted and formalized within the palatial political and economic organization. More specifically, they posit that pre-state communities expressed kinship connections through mutual exchange of labor, hospitality, and commensality, and they expanded these networks as needed through gift and marriage exchange.[502] Cooperative labor was essential for intensive farming practices, especially during harvest time, and was both expected and rewarded with gifts and feasts. This arrangement constitutes *balanced reciprocity*, where there was a mutual expectation of reciprocity, and the period of indebtedness was brief. Where hierarchy and inequality appeared, "large houses led by well-connected

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[497] *Du-ni-jo* is atypical, as most of the servants of the gods are absent from other documents, however his (or their) plural functions lend credence to the part-time nature of the service responsibilities of the rest.

[498] Feasting in Mycenaean society is well attested and the subject of much scholarship. For more on this topic see (selected): Bendall, 2004; Dabney et al., 2004; Dietler & Hayden, 2001; Fox, 2012; Halstead & Isaakidou, 2004; Killen, 2015; Nakassis, 2012; Palaima, 2004; Stocker & Davis, 2004; Wright, 2004.

[499] Palmer suggests that *i-qo* (and thus the gen. *i-qo-jo*) should be read as Hippos (*cf*. Apollo Hippios/Hippos) rather than hippos ἵππος "horse" (Palmer, 1963, pp. 277-278).

[500] This term is understood as a religious title, loosely translated as "the superintendent of honey," and has a parallel with the title *po-ro-du/da-ma-te* "the feather/wing superintendent." Rogard Woodard makes a connection between the Linear B duma/dama comes from the Luwo-Hittite *dammara*, a religious functionary (Woodard, 2021; Jared Petroll, 2022, personal communication).

[501] Galaty et al., 2016. See also: Earle & Ericson, 1977; Earle, 1982; Renfrew & Shennan, 1982; Smith, 2004; Stark & Garraty, 2010.

[502] The framework of the pre-state social organization is based on observations from the Shala Valley Project, a long-term ethnoarchaeological study of communities in Northern Albania, which, they argue, is a modern approximation of non-state (in this case pre-palatial) social modalities (Galaty et al., 2013)

patriarchs would have attracted reciprocal obligations (i.e. indebtedness) and impulses to 'give it all away' that characterize small-scale polities could have morphed into local 'redistributive' systems."[503] In these instances reciprocity became less balanced, and the period of indebtedness would have been longer if not persistent. The authors further suggest that the "redistribution" that the state enforced was simply an institutionalization of the hospitality and commensal conventions that scaffolded all prior social arrangements.

Finally, with the institutionalization of the negative-reciprocal redistributive apparatus, which systematized indebtedness (non-reciprocation) toward the palace, pressure was placed on other elite classes to disrupt long standing *balanced* reciprocal arrangements. Rather than reaping the benefits of mutual exchange, wealthy individuals, under state coercion, would have been implored to give without repayment in order to facilitate redistribution. Taxes, for example, were collected and redistributed formally, but compensation (gifts? Special privileges?) may or may not have been issued. Donations to large-scale feasts also contribute to the negative-reciprocal redistribution. *Du-ni-jo*, a wealthy Messenian, provisioned a feast at Pylos with livestock, wine, olives, and barley, which benefited the community (who enjoyed the feast) but cost *du-ni-jo* significantly. The donor could not have expected every participant (likely in the 100s) to provision a compensatory number of feasts to balance the exchange; however, by his (forced) generosity *du-ni-jo* would have profited nonetheless in the form of favor, social capital, and indebtedness. In fact, Morris confirms that this costly asymmetry was enabled by religion;[504] within the context of ritual feasting and gift giving (votives), separating the wealthy from their wealth becomes a highly

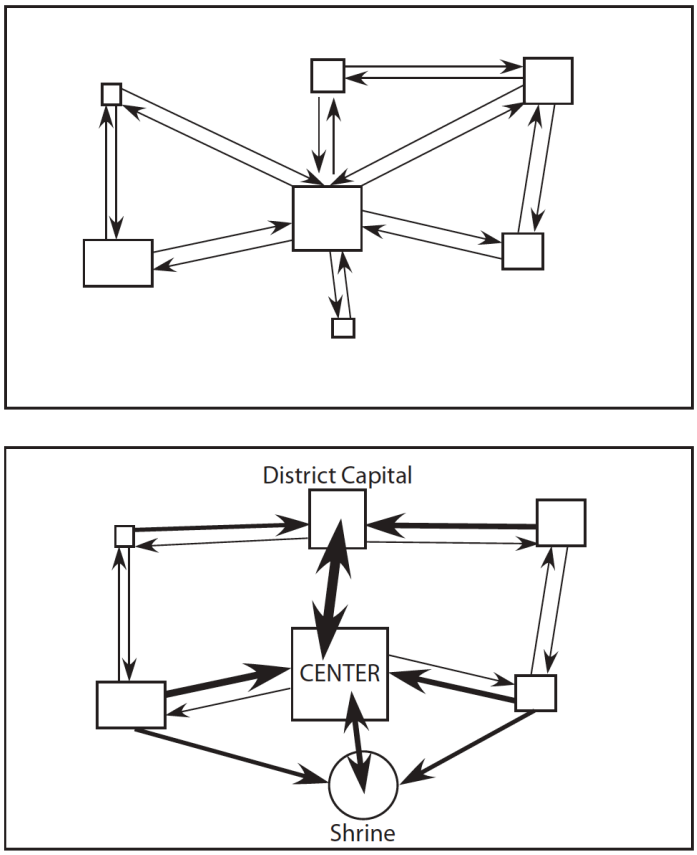


Figure 4.9 Idealized sketch of a regional system of balanced reciprocal exchange, as might take place between houses; (bottom) idealized sketch of a regional system of redistribution, characterized by negative reciprocal exchange, as might take place between regional center (i.e. a 'palace') and its subsidiaries, including 'district capital' and 'shrine.' Taken together, these sketches represent the changes that would have marked the shift from prepalatial to palatial systems of exchange. Arrows indicate exchange directionality and, by their weight, the relative number of goods transferred (Galaty, et al., 2016, fig. 2)

[503] Galaty et al., 2016, p. 66.
[504] Morris, 2016.

symbolic act with very real economic consequences.

It is here that I would like to situate the E-series. Landed wealth was alloyed, to some degree, with polydirectional debt and obligation. In exchange for the rights they possessed, land-holders owed the palace taxes in the form of grain, other goods/commodities, and people. In addition to–or perhaps in lieu of– the taxes paid to the palace, land owners also were compelled to share the fruits of that land with members of the community as payment or viatica for their services in religious festivals. The degree of formality may have differed between these exchanges; the former was likely mandatory, while the latter could have been voluntary (though highly coerced). Much like the Classical liturgical system, landed wealth *granted* one the privilege to partake in philanthropic spending and as a consequence *obliged* the wealthy to do so. In the historical period this type of spending took several forms: the trierarchy, which funded the construction of a trireme, and the sponsorship of particular elements of religious festivals, the most famous of which being the *choregia*. As time went on the liturgical obligation became increasingly formalized, culminating in the 4th c. BCE when it functioned essentially like a compulsory tax. In its nascent state, however, "the performance of liturgies was encouraged by informal rules that worked both as socially sanctioned norms of behaviour and as a convention that liturgies brought status."[505]

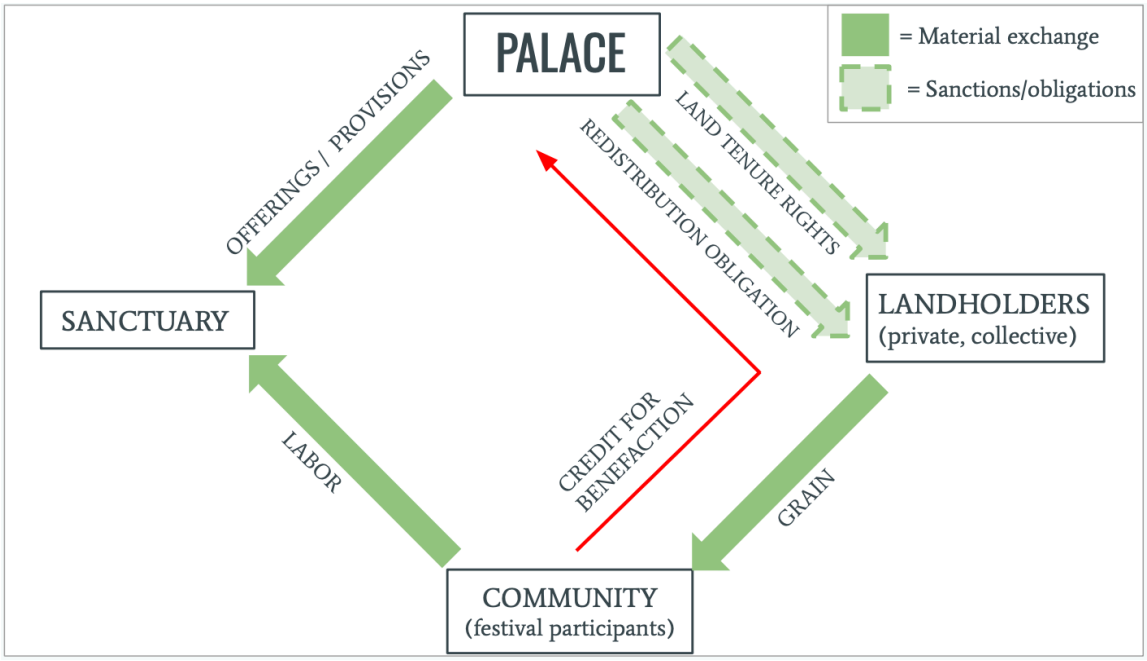


Figure 4.10 Schematic of the proposed E-series transaction. The palace participates in the transaction in non-material ways by enforcing the legality of land claims and obliging those landholders to participate in local redistribution.

It is not my objective to argue here that the origins of the institution of liturgies reaches back to the Bronze Age, but I offer it as a correlate of this persistent entanglement between the socially mediated/symbolically lubricated pressure to spend without expectation of tangible returns and land

[505] Lyttkens, 1997.

rights. This arrangement is equivalent to that witnessed in the *do-so-mo* documents (see p. 145). There, taxed grain is transferred to the state *and* to gods/sanctuaries. In this case, the state upheld the rights of the damos and of private landholders and acknowledged the definition of those property boundaries, as is implicit in the formula, and in (re)turn those landholders engaged in negative-reciprocal "redistribution" both centripetally (taxes, labor, and goods to the palace) and centrifugally (donations to the sanctuary and festivals, likely among other things).

The format of the E-series reveals exactly this entanglement. *mu-ti-ri*, a servant of the god, is not listed laconically alongside her 12 liters of grain but rather was entered into the record as holding the benefit or reward derived from a landholder (in this case the damos). In each entry the landholder got named credit for gifting the grain, and their κτοίνα is referenced because it justified the gift; it was because they were landholders that they were obliged to be benefactors. The title *te-re-ta*, a "tenure-bound status word"[506] that evokes the fulfillment of some service to the palace, further tethers the service (disbursals of grain) to the land. The service summoned, at least in part, was that of local redistribution. If we return to Table 4.2, it is apparent that, while others held private properties, the *te-re-ta* (as well as the two property owners who substituted payments for a *te-re-ta*) shared their wealth much more consistently. Whether, like a liturgy, these transactions were scheduled/recurrent, or they were levied in an emergency (religious festival to ameliorate the prolonged period of drought and scarcity?), the palace's interest in a transaction of this kind is much more clear than in the case of the leasing program, since the social fabric of the kingdom and indeed the state's ability to mobilize wealth and resources were reinforced by systems of reciprocal obligation. The palace was invested in wealthy landholders opting in to local redistributive programs, especially when they stood to benefit from their position on the social capital up-line. In other words, in the context of a *state* sponsored festival, individual benefactors accrue borrowed status; a shepherd earns a gift *from the estate* of a landholder but *by the hand* of the palace. These tablets therefore document an investment, of sorts, if one-step removed.

When the palace can mobilize local wealth, they don't have to tap their own grain stores and expend their own wealth in order to "give it all away," doling out payment to the festival participants. Sharing resource assets in festivals and feasts fostered loyalty, contentment, and, most importantly, indebtedness. Landholders would have been motivated to participate in an informal but socially prescribed decentralized form of taxation (liturgy) by promise of these rewards, and the palace would have been likewise motivated to compel such exchanges so that the positive outcomes could be secured (by enforcing an equivalent distribution of their notional territorial wealth) with minimal investment. They used the local landholders as a substitute for themselves in the matter of small redistribution, and this system had three advantages: 1) the palace could sponsor a festival without using its own material wealth to compensate participants, 2) the landholders could retain their land-tenure privileges by contributing their (grain) wealth to festival participants, and 3) both the palace and the landed would be credited as benefactors, which raised the esteem of each party. All of this, much like the Hittite food-gifts record, was facilitated and justified by religious/symbolic obligation and meaning. We, of course, do not have these agreements, but rather we have the *outcomes* of these agreements: land rights

[506] Palmer, 1963, p. 191.

were acknowledged or gifted to private landholders and the *damos* with the expectation of taxes and redistributive benefaction.

4.4 Conclusions

The narrow glimpse into the economics of Mycenaean land tenure systems that the tablets provide is obscured by etymological uncertainties, unknown administrative systems, and abbreviated recording conventions; nevertheless, certain things are clear. First, in the two towns noted in the E-series, but likely more if not all of those belonging to the Pylian kingdom, *communal* tenure rights were the standard, while privately held lots were few and exceptional. From a modern vantage point it is difficult to dismiss expectations of personal, heritable property ownership as well as profit maximization, and individual wealth accrual objectives. In the Bronze Age and beyond, the appearance of social stratification is so often bound to landed wealth that the idea of drawing boundaries on the ground and atomizing the landscape into discernible nodes of social/economic advantage seems *natural* to sedentary agricultural lifeways. Yet in a collective ownership paradigm the community is the basic unit of measurement, rather than the kin group, family, or individual, and what is heritable is not a parcel but the *right* to cultivate (usufruct) on circumscribed village land.

This is not an uncommon strategy, even where social hierarchies and formal states exist. In North Western India, for example, late-19th century observations were made about real communities of ownership in provincial villages.[507] Here, large "village estates" were composed of arable and "waste" (pasture) lands and separated from the wilderness by a ringed boundary fence. Usufruct was inherited through maternal lineages, parcels of cultivable land were distributed for seasonal use, and the fruits of the land were pooled and redistributed through communal dining. Lots were rotated yearly so as to fairly distribute higher quality zones, and population growth was accommodated by the clearing of new agricultural fields and establishing satellite villages beyond the boundaries of the parent community. In Goa, prior to its capture by the Portuguese in 1510 CE, a 1,000+ year old collective village institution, given the exonym *communidades,* administered three types of village land: common properties, private properties, and state properties. Similar to the previous example, communal possessions were composed of stretches of arable, waste, pasture, and forest land. Private properties were not cropped out of the community holding, but rather were developed from waste land and held in perpetuity by the individual who invested the labor required for its productive transformation (with a 25 year tax break to boot).[508] Interestingly, these varied forms of ownership coexisted, an important note given the tendency to assume that the latter system evolved out of the former, prescribed stages in the progress of technological and "cultural" development.[509]

The Ibo in Eastern Nigeria intensively farmed yams in rotating blocks around the village, whose institutions of communal ownership administered the shifting distribution of plots, cultivation

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[507] The following sources ascribe to outdated, inaccurate, and deeply problematic views of race that I neither condone nor wish to bring awareness to, however I note them here as sources of ethnographic observations stripped of their contemporaneous interpretations: Baden-Powell, 1898; Hewitt, 1897.

[508] Shastry, 1988.

[509] Netting, 1986, pp. 77-78.

practices, and redistribution of the produce. When the population outgrew the confines of its land resources, individually tended domestic gardens grew in importance and size, eventually overcoming (both spatially and in labor investments) the communal property.[510] Finally, in the Brazilian Cerrado the Canela utilize several ecoregions for plant cultivation, including cleared forests, river banks, and domestic garden spaces. Each family migrates plots at different intervals depending on the soil requirements for the species of cultivar planted and allows each plot a short, medium, or long fallow period. While these plots are held by individual families, their actual possession of it is temporary and is manifest only while their crops are growing there. To the extent of their territory, therefore, the "rights are those of usufruct–of possessing the products of the land but not the land itself," which is communally available and only momentarily claimed.[511]

With just these scattered examples it is evident that the individualist property owner ought not be our explanatory default setting and, most importantly, that the internal organization of common property management takes many forms. In some cases the labor, land, and produce are pooled in every respect. In other cases, such as the Canela and the Ibo, the individual plots are disbursed but rotated in order to promote fairness. Adaptations for population growth are also diverse, with some communities expanding arable territory and others replacing communal properties with private ones capable of sustaining just one family. Everywhere these decisions are culturally situated and partially dependent on the landscape and the measures taken to cultivate it. In fact, there is a statistically significant correlation between communal ownership conventions and shifting agricultural practices with low population densities, and conversely, private ownership and intensive farming methods with high population densities.[512] This is quite intuitive, since longer fallow periods require less costly fertilization and long-term irrigation investments, allowing for a transient relationship with cultivable plots. Clearing of bush or forest from a selected area is the investment that lays claim, however temporarily, to the plot itself but is a frequent practice common to all whose farming loci shift across the landscape. With the investment of labor with long-term objectives, however, such as fertilization, the construction of irrigation channels, mounding, and/or erosion control, the prospect of *another* individual making later gains from one's own costly labor expenditure becomes less palatable. These changing practices often come as a result of population growth, whereby the available land becomes scarce, and the yearly planting cycles with short fallow periods necessarily predominate.[513]

At *pakijane* and *ti-no* just such population pressures mounted as, buoyed by consistently higher atmospheric moisture levels, populations within the area of study (the pollen catchment zone) jumped from ~500–1,100 individuals to ~3,780 individuals between the Middle and Late Helladic Periods.[514] Moreover, the available land was limited by the steep, unarable slopes and ridges that ring the coastal plains of the Navarino area. A turn toward *intensive* farming practices, at least in part,

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[510] Netting, 1986, pp. 78-79; Udo, 1965.

[511] Netting, 1986, p. 78; Miller, 2019.

[512] Seventeen groups were compared in the New Guinea Highlands for this study: Brown & Podolefsky, 1976.

[513] This statistical correlation is explanatory, but not necessarily *predictive*. It would be reckless and a step too far into environmental determinism to assume that in every case low populations and shifting farming methods beget absolutely communal property arrangements, and vice versa. Rather, these are simply *tendencies* observed ethnographically.

[514] See Chapter 2 for a more detailed description of the area of study and the population changes therein.

beginning in the Early Mycenaean Period would have been a probable adaptation to changing demographic conditions. The patches of open spaces gradually narrowed, as fields once left to fallow for years or decades would have been brought under continuous cultivation, perhaps planted twice per year, with a short or absent period of recovery. The E-series also reveals that at least by LH IIIB, if not earlier, the imposition of extractive state mandates must have changed agricultural practices, especially if synchronized with population growth. Taxes *and* liturgical obligations would have incentivized farmers to maximize their productivity such that they could offset the loss while maintaining subsistence levels.

With the swelling caloric burden of a growing population combined with coercive extraction, family groups may have settled adjacent to the circumscribed village land or on village pasturage, waste, or forest areas. Previously unused/unusable tracts demand costly investments in order to transform them, perhaps by terracing, irrigating, and/or clearing boulders and stumps, into newly productive and privately held fields. Success would have been at least partially dependent on the ability of the intrepid farmers to mobilize a labor force, either by having a large kin group, social capital/persuasiveness, or some other means. The documentary evidence from LH IIIB illustrates that private farms owned by the *te-re-ta* and others were already operational and productive, meaning their claim (either granted by the palace or independently) had been long established. In a comparable arrangement to that of pre-colonial Goa, newly settled private land may have coexisted with communal village land, which in fact is consonant with the etymologies of the principal property distinctions: common *ke-ke-me-na* (related to κεῖμαι "laid out, stored up, established") land was established, bounded, shared, and, like all CPRs, "not public nor private [but] geographically confined and... not open to all,"[515] while private *ki-ti-me-na* (related to κτίζω "founded, built, settled, planted, brought into being") land must be settled, transformed, and constructed. Within the territorial confines of the *ke-ke-me-na* land, intensification likely also took place, however the *individual investment* in land that had already fed the community for centuries would have been less extensive and less variable between family units. In such circumstances it is easier to share in the fruits of *equal* labor, and the E-series testifies that they did exactly that. Based on the record of liturgical disbursements, damos grain resources continued to be pooled. Whether by wholly collective labor and the absence of internal boundaries, or by shifting usufruct to centrally administered plots that carried with them an obligation to share seed-grain with others, collectively owned land yielded collectively held/stored grain resources from which expenses were paid and community subsistence was maintained.

Consolidating resources under any communal land tenure conditions yields substantial risks of opportunistic behaviors that Hardin foresaw, such as free-riding, breaking promises, and short-term gain efforts. In the context of this study, this may manifest as individual produce hoarding (rather than pooling), improper or absent soil fertilization that sacrifices the total yearly output of a field, shirking weeding responsibilities and thus diminishing the proportion of consumable grains harvested, or complete abstinence from planting, harvesting, or assisting in the farming process of other community members. These issues are particularly acute if plots are tended individually in perpetuity or rotated

[515] Dasgupta, 2005, p. 1611.

between family units periodically. As such, governing the fair and sustainable appropriation of land resources (here: arable land) by its users is fundamental to the stability of the arrangement.

Parallel to, or possibly in competition with, the institutions involved in communal land-use practices were those that developed around private land. When those with the resources to quickly develop arable tracts in the *eschatia* separated themselves from the pooled labor and supplies of the village collective, the necessarily cooperative efforts involved in farming, such as harvesting, tilling, and improving the land, would have become abrupt challenges. Luckily, however, with the appropriation of existing reciprocity and hospitality institutions, recurring reciprocal labor could be promised in exchange for hosting feasting events and the sharing of special and/or non-local items.[516] The survival of private landholders thus depended upon *and* boosted their elite status. Controlling their own surplus allowed these individuals to deploy it in necessary demonstrations of wealth and status, which those engaging in collective farming whose surplus was a collective asset could not do. There is also a possibility that, beyond their grain surplus, private landholders may have also controlled other resources connected to their holding. The *te-re-ta*, whose heterogeneous and sometimes unmentioned vocations make them likely candidates for early land developers as opposed to recipients of palatial land as a labor retainer, are moderately involved in fuel dependent occupations: potters (n=1) and bronze smiths (n=3). This slight correlation opens up the possibility that the control of wood fuel resources facilitated their success in their respective industries and drove the unchecked (ab)use of the local pine stocks.

While the relationship between the collectivist and the individualist institutions is not known, it is easy to imagine that tension would have emerged, as hosting and commensal performances amplified the gulf between the social strata. Perhaps the conspicuous surplus and heightened status of the elites (*te-re-ta?*) tugged at the seams of village order, inciting jealousy and ultimately noncompliance with the proscriptive regulations of the damos. Ultimately, though, what is evident is that demographic growth in the Early Mycenaean period coupled with the palace's extractive regime incentivized farmers with higher social capital to break from the community in order to settle and develop new properties. This observation is harmonious with the pollen data, which attests to the clearing of woodlands and maquis and the spread of open grasslands during the Late Helladic Period.

[516] Galaty et al., 2016, pp. 64-65.

5. CONCLUSION

There are aspects of the human social and cognitive world that have, for good reason, been understood as irretrievable from prehistory. We can observe evidence of ritual action but refrain from making claims about the cosmological beliefs that anchor it. We may also discover indications of destruction and even warfare, but we would never claim the cause was a broken marriage contract, a land grab, or a conflict over succession. The questions asked throughout this project breach this epistemic boundary inasmuch as they explore the archaeologically invisible forces that shape human engagements with the landscape. To ask whether there was effort made toward conservation demands an understanding of community values, and to assemble the traces of institutions governing fair and sustainable resource-use prompts the examination of embedded beliefs about entitlements (personal and collective), concepts of ownership, and correct/incorrect behavior. In understanding how the presence of the state might have changed these relationships and behaviors, moreover, one is impelled to unravel both the state's conception of itself and the means by which its interference with community institutions justified its own existence. To transgress this boundary responsibly, it was necessary to maximize data catchment and layer archaeological, topographic, palynological, survey, documentary, ethnographic, demographic, and climatological evidence such that the incalculable diversity and number of possibilities narrows to just a few. *Beliefs* and *values* are invisible, limitless cognitive categories that hold every potential iteration of human thought, but the outcomes gleaned from stacked data can exclude potentialities that are inconsistent with archaeologically traceable effects. As a result, the previously irretrievable social forces in Bronze Age Messenia come into focus.

For the two CPRs examined in this project, forests and arable land, evidence emerged of collective management institutions that fostered sustainability and assumed community level costs and benefits. Deciduous oak resources were conserved throughout the Middle and Late Bronze Age despite consistent population growth and shifting consumption patterns that required intensive extraction. Rules concerning appropriate use seem to have been assigned only to this taxon, as pine simultaneously suffered a steady decline until it was ultimately deforested completely. Evidently, pine shouldered the burden of elevated demand, while behavioral restrictions (perhaps including restrictions of access, coppicing, pollarding, or the exclusive use of fallen deadwood) sheltered the oak and its high-value hardwood. This outcome attests to only a handful of possible attitudes toward both the conserved and the exhausted resources; certainly the longevity of the deciduous oak populations was understood collectively as vital, so much so that immediate sacrifices would be made with respect to fuel and timber quality in order to maintain healthy and enduring stock. Meanwhile ad hoc appropriation patterns without limits were deemed suitable for the pine and reflected a consensus in its assigned value; the longevity, health, and even geographic proximity of pine woods were not a concern for the population of users, and thus the pine itself, at least in its living condition, was valued less.

Not only is this relationship distinct from the first anthropogenic deforestation event ca. 1800 BCE, when oak was systematically removed from the fertile coastal plain in order to accommodate a shifting cultivation scheme, but it is also the inverse of the pattern we see elsewhere in the Mediterranean during the Bronze Age. At Çamlıbel Tarlası, Turkey and in Kargali, Russia, for example, oak wood was the primary fuel source, and large trees were removed in order to accommodate

the expansion of metallurgical processing in the Late Chalcolithic and from the Early to Late Bronze Age periods, respectively.[517] In Kaman-Kalehoyük in central Anatolia, not only did oak woodlands provide the primary fuel source for the settlement from the Middle Bronze Age (MBA) to the Early Iron Age (EIA), but they shifted to pine primarily in the following occupational period.[518] Not only does this reveal a pattern of oak preference and preference-first extraction, but in the case of Kaman-Kalehoyük it is the precise inverse of the Messenian outcomes.

In addition to the presumed value differential, certain embedded orientations towards these resources can be approximated with the aid of a heuristic tool that schematizes the elements of social cognition influencing these engagements and preferences. As such, we can expect that *with respect to oak* there was an overriding sense of scarcity that prompted the effort and sacrifice of conservation. Were it not viewed as scarce, then there would be no impetus to curb extraction. Moreover, the community of users were investing in long-term gains, perhaps making available a vital resource to future generations, and these profit horizons were immune to the increasingly incentivized immediate returns when social and economic complexity ratcheted up the industrial outputs and caloric burden of the local population. These embedded beliefs and values, as pared down and approximate as they are, influence choice and make possible the outcome evident in the palynological data. In other words, the conservation of oak woodlands was only possible because cognitive norms begot at least sustainable appropriation mores (informal institutions) and at most the evolution and formalization of rules and penalties surrounding oak wood extraction.

The careful management of one population of trees *in combination* with the excessive overuse and destruction of another is a signature feature of a moral forest, a vision of the forest as an inherent good, where sustainability is facilitated by at least social norms and codes of behavior. Violators may have risked social penalties ranging from, perhaps, furrowed brows to ostracism, but more likely it was facilitated by explicit rules and formal penalties for non-compliance. Certain areas and taxa would thus have been protected from the logger, the goat, and the farmer, at least as much as was necessary to maintain the health of the living population. Yet the indispensability of timber and fuel sources as well as fertile pasturage would have compelled a relationship with resources beyond the circumscribed, protected area that served these needs. This is the crop forest, a vision of the forest as an instrumental good, and it is this foil to the curated, managed oak exploitation that defines the moral forest vision. It is not a general attitude towards or demand on the forest that results in stability and sustainability but a bifurcated valuation: some trees must be protected from overuse, being perhaps more valuable in their living condition (symbolic value) or so valuable as a commodity that their continued availability is a prime concern, while other trees are viewed merely as latent profit, comfort, or even obstacles. It is precisely *because* the oak woodlands were circumscribed that the pines were deforested and *because* the pines had less value in their living condition that the community could afford to protect the oaks.

Considering the period at which these behaviors become pronounced in the vegetation record, ca. 1700 BCE, it is most likely that the pressure to procure in compliance with the rules was community generated and community enforced. The new behaviors coincided with a period of social

[517] Marston et al., 2021; Garcia et al., 2010.
[518] Wright, 2018.

change wherein certain people within communities began to individuate themselves through ostentatious display, ritual, and symbolic objects. The moment of transition, between MH III and LH I, also was witness to the height of Minoan power and the burgeoning Aegean cosmopolitanism. Voutsaki and others have argued that the "intrusion of Minoan and Cycladic goods may well seriously have disrupted the segmentary structures and more egalitarian ethos of the MH" and ultimately spurred the performance of social differentiation.[519] As communities shifted from kinship networks to centralized nodes of authority, this new frame of reference and the competitive impulse drove new consumption practices. The newly adopted deposition of material goods in grave contexts, for example, took those objects out of circulation, thus increasing demand for new (and finely wrought) goods to enter the exchange market in their place and incentivize further performances of wealth and status. While grave goods are a mere symptom of a larger social trend, we can trace clearly in the archaeological record how these initial steps actualized the industrial and productive maximization evident in the latest stages of political consolidation in LH IIIB. Social change prompted new consumption patterns, and those patterns necessitated and facilitated further social and political change.

What is pertinent here is the behavioral outcome of the gestures towards individuation and personal status, not the presence and ultimately the decisions of the nascent elites. The point at which the pine and oak trajectories diverged was so early in the state formation process that the assumption of total command over resource-use in a large, highly populated region is dubious, and there is little evidence to support large-scale, top-down regulatory directives. Rather, it was the changing consumption incentives and costliness of status creation that gave rise to the first governing principle of collective management and sustainability outcomes: an overriding sense of resource scarcity. From this cognitive norm emerged enforceable procurement protocols that withstood the mounting demand pressures of the Late Helladic, and the community of users took on the responsibility of enforcing it, at least at its inception, because there was no other extant authority that could do so.

Unlike a CPR management institution governing, for example, an irrigation system, forest management in an agro-pastoral economy must balance the needs of several overlapping groups of users. The motion of the woodcutter's ax was not alone directed, but it was also that of the pastoralist's herd and the farmer who periodically (re)claimed a segment of the forest for cultivation. Areas with sparse tree cover may have been claimed semi-permanently by farmers who took advantage of their fruits and nuts. Social and geographic boundaries may have been defined, but perhaps defined in a way unintelligible from our modern vantage, operating on non- or multi-year timescales and modified according to natural signals. A herder may have access to an oak stand but must minimize the consumption of new shoots, or he may seek plots recently left to bush/forest fallow. Particularly dry or wet years may initiate different sequences or modes of land use. This requires the knowledge not only of one's own vocation and the many permutations of its setting but also the knowledge of that of the other communities of users, or at least an understanding of how competing needs ought to be accommodated by a system of property rights in order to reduce friction. In such a scenario, where agents with varied interests belonging to diverse vocational groups interface in a potentially

[519] Voutsaki, 1998.

competitive resource procurement site, the advantages of a formal institution/institutions becomes evident; these are likely higher transaction costs than an irrigation system or a forest that is delineated from private properties, since the forest specific knowledge belonging to the herder, the farmer, and the woodcutter may differ, their relationships to one another may be less, if at all, established, and their needs and the rhythms of their movements may not be perfectly harmonious. Consequently, the *trust* that others in the community have made a similar commitment to them, even when tempted by immediate/individual gain, *assurance* of sustainable and mutual gain through compliance, and *confidence* that noncompliance is detectable and sanctionable are achieved much more easily under formal institutional conditions.

With the formal emergence of the Mycenaean state ca. 300 years later, the locus of institutional authority changed in one key way. Rather than oak wood exploitation being viewed as the managed threat, oak timber and fuel appear to have decoupled and managed under auspices of different authoritative bodies. On the one hand, fuel appropriation remained a collective asset managed on a community level. Palatial documents, despite being categorically and resolutely detailed, are absent of any reference to the collection or distribution of fuel wood, even in pyrotechnic production contexts. Fuel wood appropriation institutions, therefore, belonged to community agents and, likely, community organizations. In Mawlyngbna, Meghalaya, India, for example, every family regardless of wealth or other claims of private property are allowed to apply yearly for the right to fell 50 living trees. They may also hold privately owned forest parcels, which are often exploited much more heavily, but those private parcels must be available to all villagers as a quarry source. The right to withdraw from the collectively owned forest is administered by the village council, monitoring is undertaken by village members/resource users, information about infractions is shared at community meetings, and disputes are arbitrated by the village headman.[520] In this instance the state has no input nor any obligation to generate forest governance policy that conserves this salient resource, and the robustness of the community institution is underpinned by strong cognitive norms. Namely, "respondents traced their motivation for preservation to an inherited obligation from their forefathers' initial dedication for [the forest's] protection."[521]

On the other hand, the palace reports the acquisition and movements of timber explicitly. They concern themselves with the appropriation and allocation of oak timber for a chariot workshop and possibly the construction materials for the megaron, both investments belonging under the umbrella of statecraft. Despite the timber-saving construction methods of the pier-walls, archaeological evidence from the Palace of Nestor demonstrates undeniably that the palace (and likely other monumental administrative buildings) were immensely costly to oak populations. Without knowing the volume of chariots manufactured, it is clear from Pylos document Vn 10 that on one occasion 100 oak wood units (trees, boughs, or saplings) were put to use in their construction. This was likely episodic and may have been repeated monthly, seasonally, or yearly. While the documents may not have survived, it is also possible that shipwrights were supplied timber through palatial conveyance, since labor groups associated with ship construction are extant in the surviving records. In summary, the

[520] Oberlack et al., 2015.
[521] Oberlack et al., 2015, p. 680.

palatial administration focused its supervision on the withdrawal of oak timber at a scale incomparable to that of any one community.

This indicates, at least, that they changed the *constitutional-choice rules*, which are the "formulation, governance, adjudication, and modification of constitutional decisions."[522] By making an exception for themselves, allowing for the scale of their own consumption, the palace modified *who* can withdraw *how much*, and by relitigating these procurement limitations on their own accord, they revised *who* was entitled to change *what* operational rules. Whether by design or by chance, a palatial consumption exemption changed the institutional infrastructure. Any change to the rules, but especially in the case of the deeper, more conservative constitutional set, increases uncertainty, because trust in the system and the expected benefits of opting-in become less stable and thus less predictable.[523] In summary, by the very fact that the palace consumed oak more heavily, they ultimately seized control of the collective institution *and* undermined its stability.

The second common-pool resource in focus, arable land, invites discussion centered not on sustainable use but rather on privatization. In this case the interference with sharing institutions has less to do with community versus state appetites than it does community versus state incentives, coercion, and opportunity. Yet in both arenas, demographic growth appears to have been the primary driver for institutional change.

As mentioned above, evidence for social stratification prior to MH III is scant, and perhaps our default assumption ought to be that community, rather than private, structures of ownership prevailed. Agriculture is, naturally, a collaborative activity, since sowing, tilling and harvesting require an abundance of labor in short bursts, and none at other times. The environment, particularly in eastern and southern Greece, makes buffering against food insecurity a necessity. In these cases buffering can take the form of food storage, food sharing, and/or social storage, the latter two strategies being products of socially enforced sharing institutions.[524] The advent of agriculture thus doesn't automatically result in the parceling out of small, autonomous farmsteads, but rather the opposite. People relied on each other at harvest time, at sowing time, to maintain beasts of burden, and possibly to pool or divide their yields.

When MH populations in the pollen catchment area (PCA) rebounded following the devastating 4.2 kya event, the laying down or circumscription of long-tended community properties may have become necessary. An early locus of discrete, habitual, and intensive farming may have, in fact, been the coastal plains just north of the Navarino Bay, which, according to the pollen record, was likely cleared of its forest cover in the interest of transforming its well-nourished floodplains into fertile fields. The prodigious UMME and PRAP surveys offer a rare holistic view of settlement patterns throughout MH Messenia. While the dating of the sites was based on surface pottery and therefore less precise than, say, stratigraphic excavation or C14 dating, the results demonstrate that, unlike elsewhere on the Mainland, settlement sites grew in *both* size and number. Elsewhere, the prevailing trend in site distributions is characterized by smaller hamlets nucleated into larger composite communities, which

[522] Ostrom, 1990, p. 52.
[523] Ostrom, 1990, pp. 52-54.
[524] Hastorf & Foxhall, 2017, p. 26.

gives an impression of widespread site abandonment and depopulation.[525] In Messenia, while there is evidence of similar tendencies, each site grows while also spawning new subsidiary sites.[526] Based on these data, Jazwa and Jazwa (2017) modeled settlement patterns using an Ideal Free Distribution (IFD), assessing the quality of the site location against the sequence of their appearance according to the surveys.[527] They found that the majority (74-76%) of the EH III-MH II (LEMH) locations were within areas with the highest habitat suitability, which was calculated based on watershed size (proxy for fresh water availability), mean net primary productivity, and their distance from the Palace of Nestor. By *at least* LH I-II, newly established settlements were, however, relegated to lower quartile locations in many more cases (34%). More than simply illustrating population growth in Bronze Age Messenia, this model demonstrates *how* growing populations engaged with their landscape. In arid regions the presence and abundance of fresh water sources is a keystone of survival, yet as communities grew, they were compelled to settle lower order, less fertile watersheds/locations within watersheds.

With this in mind, the conceptual change from the cultivation of community land to bounded and particular collective properties is implicit. The "infield" where farmers returned to plant crops yearly may have developed discrete boundaries, as opposed to the shifting plots won from the forest and left to regrow dense vegetation under a bush or forest fallow regime. The boundedness of these communal holdings precipitates further cognitive changes, since the land becomes heritable. Access to the productive cultivation nucleus may not be automatically granted simply because one resides in a community, but rather mediated by group identity, kinship, or houses.[528] This lineage may go back many many generations, and may include every resident in a given settlement, but the shift from "we tend the land around us" to "we tend the land in this particular area because it is a right we inherited from an ancestor" is significant.

This accords with the etymology of the principal property distinction, *ke-ke-me-na*, which is village land cultivated by community members. The term is related to κεῖμαι "laid out, stored up, established," suggesting it had been organized and set apart from other properties/territories. If identified as "laid out," this qualifier engages more tangibly with the practices of agriculture. Laying out one's field may have meant tilling, clearing of bush, or marking out the boundaries and edges. Κεῖμαι can also have the valence of something being set up/ordained, goods or property being stored up, or of continuing conditions, remaining. However the term was applied, the sense is that it had "clear territorial and social group boundaries," which were likely inherited or acquired by community affiliation.[529]

Based on the grain distributions recorded in the E-series tablets, it is apparent that the community pooled either the entirety of their grain harvests or at the very least their grain surplus, which was doled out to participants during a festival in LH IIIB. Those entries that cite the source of the disbursement as *pa-ro da-mo* (παρό δαμῳ) attest to the existence of communal produce storage (at

[525] Spencer, 2007, pp. 33-36.
[526] For example, 2-3 EH settlements on Epano Englianos coalesced into one site in the MH (Davis & Stocker, 2006).
[527] Jazwa & Jazwa, 2017.
[528] On pre-state social organization: Efkleidou, 2020; Nakassis, 2022; Voutsaki, 2010. On the interface between social organization and claims of land: Adler, 1996.
[529] Robinson, 2019, pp. 804-826.

the settlement granary?) at the end of the Bronze Age, since they elide acknowledgment of any named contributor. The *da-mo* here ought not be interpreted as the community altogether but was, rather, a corporate body that represented and administered community holdings. While indeed this particular transaction, the liturgical festival disbursement, may be a later, palatial phenomenon, the collectively held real property and the practical realities of community, rather than individual, wealth accrual were in my estimation holdovers from this earlier period at which time village land and communal property were the default property ownership arrangement. Additionally, along with pooled grain reserves, a suite of other behaviors can thus be inferred.

When independent actions and choices of individuals directly affect collective gain, as is the case with suitable land-use practices, the reinforcement of propriety is most effective when social norms and codes of behavior (informal institutions) or explicit rules (formal institutions) limit the field of choices an individual is willing to make.[530] In order to avoid shirking, free-riding, and opportunism and to achieve "cooperative equilibria" in communal tenure arrangements, enforceable behavioral conventions must develop.[531] A common sense behavioral rule such as *contributing nothing to the pooled harvest is selfish,* or *not investing in fertilizer this year is lazy* require second tier operational rules that enforce compliance, such as *those who contribute nothing to the harvest are excluded from harvest feasting events* or *those who shirk fertilizing obligations are given a less productive field the following year*. While operational rules and/or penalties may change, the foundational behavioral rules belong to a shared understanding of right and wrong. As we can all likely testify from experiences in our own lives, however, beliefs and customs pertaining to right and wrong actions do not alone engender the trust, assurance, and confidence mentioned above, especially in desperate situations. In school, for example, one may know that cheating on an exam is wrong, however they would be disincentivized to take the exam honestly if they thought others would get a higher score by cheating and that their transgression would go without detection or recourse. The operational enforcement of the rules, therefore, is integral to their compliance and can be accomplished by the group of resource users or by an organization (the "damos" perhaps).[532]

For these sharing institutions to persist, the net benefits of both the investments in the land and the investments in the labor of management outweigh the costs of that labor and the loss of short-term, individual profit maximization. One might readily hand over the produce that they harvested with their own hands because of both the expected access to the communal food stores (either habitually or in a structured sharing event) and the expected denial of access to community property were they to refuse. One is also more likely to comply when there is a path to dispute arbitration, and they perceive that the results are fair. Within the institutional framework of common *ke-ke-me-na* land, the resilience of both the sharing institutions and the productive longevity of the land rely on a) the sufficient productive output of the land, b) the ease with which resource users can

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[530] North, 1990, p. 4.

[531] Ostrom, 1990, p. 43.

[532] Lupack (2008) argues that the term "damos," rather than generically applying to the community as a whole, is an organization that administers land use/rights (and likely other matters). I am inclined to agree, but either application of the term is consistent with my argument.

communicate, monitor one another, and make collective decisions (a metric based on population size), and c) the authority awarded to the governing apparatus to handle disputes and dole out penalties.[533]

Several variables make this system somewhat vulnerable. First, the establishment and marking of the land boundaries, which is essential for the sharing institutions to function, was likely done during a period of *more* and more *stable* atmospheric moisture. After the 400 year drought and up through the beginning of LH IIA (ca. 1900 BCE - 1550 BCE), there was more abundant rainfall, and the availability of fresh water within a given watershed would have been more predictable. Following this period, during the Mycenaean state-formation period, the rainfall waned, casting Messenia into periods of prolonged drought. While moisture levels periodically recovered, the stability and predictability of the Middle Helladic was lost. This means that the productive capacity of the established, layed out (Κεῖμαι) village land would diminish toward the end of the Bronze Age and destabilize cooperative equilibrium. If villagers were no longer satisfied with their share of the pooled food stores, they may be incentivized to hoard their own or change the location of their farm. Second, the period of rainfall recovery during the Middle and Early Late Helladic period also saw significant population growth, which would exacerbate the problems of food supply brought by the increasing aridity and, perhaps, make communication and monitoring more costly.

The third vulnerability is the threat to local authority. The social landscape changes when we move into the Mycenaean period, and we see evidence of differentiation of certain individuals: those buried in tumuli and shaft graves, then chamber tombs and tholoi. The family line is emphasized in multiple burials, and by extension, the clusters of tombs, and the population is lumped and split in defined ways that seem to hierarchically order certain sub-sections. This shift adds additional incentive to transgress the established sharing institutions, since more individual benefit can be gained if one were to a) hoard surplus cultivated on village land or b) bring new properties under cultivation, both scenarios potentially providing the means (surplus control and maximization) for the accrual of personal acclaim and differential status.

The Linear B evidence attests to precisely this turn. Private *ki-ti-me-na* properties coexisted with communal properties, which in many cases is an adaptive response to both increased population density and an intensive farming strategy.[534] The population growth is well attested, and the intensive farming program can be inferred from the records. By at least LH IIIB (but likely by LH IIIA), the palace was assessing and taxing the grain wealth of communities within the kingdom, *and* at *pa-ki-ja-ne* and *ti-no* an additional payment system was imposed.[535] Here, at the time of, likely, a festival, private landowners and the administrators of communal land (the *da-mo*) were compelled either socially or legally to distribute volumes of grain to festival participants, commensurate with their status or level of importance. The combination of these variables makes it very likely that more fields would have been cultivated more often, with a short or absent fallow period offset by costly fertilization schemes. In order to maintain the subsistence level of the growing population and the demands of state extraction, every year the spaces that were once idle–the fallowed fields, the shrubby interstices, the rocky slopes, and waste–would have been forced to produce. The population and

[533] Ostrom, 2009; Walker et al., 2004.
[534] Brown & Podolefsky, 1976.
[535] PY Es, En, Eo, Ep, Er, and Eq series.

climate conditions combined with the taxation and grain redistribution would have been powerful motivators for breaking out of the collective ownership paradigm and developing new, privately held land parcels beyond the precincts of *da-mo* control. Moreover, the intrinsic rewards of consolidating one's personal wealth and status within the social landscape of the Mycenaean period compounded the expected benefits of private ownership.

There are two possible pathways to private ownership, which likely took place sequentially. Prior to palatial hegemony, ca. LH I when the above mentioned forces of change first converged, villagers may have invested labor into transforming previously unused or seldom used land into permanent fields. Perhaps like 16th c. CE Goa, the front-end investment in the costly transformation afforded them interminable ownership rights as well as total control over the grain wealth derived from the property. This land was in every respect κτίμεναι–settled, colonized, peopled, built, invented–as it was won from the wild and brought under the yoke of an individual. Under palatial state control, there may have been an assumption of state dominion over unclaimed land, and further claims would thus have been state mediated: won from the state, so to speak. The archives and the transaction details of the E-series tablets testify to the landedness of named professionals who worked in service of the palace. In *ti-no* especially, craftspeople, religious professionals, and herders of every variety had both a *ki-ti-me-na* claim and an implied obligation to the *wanax* or the *lawagetas*.

It cannot be known for sure how these pathways to private ownership align with the two extant categories of landholder: *te-re-ta* and non-*te-re-ta*. Both sets are tethered to some burden of palatial service. Those without the title of *te-re-ta* have, as was previously mentioned on p. 156, professional titles that make them likely candidates for compensatory land grants for specialized craftwork or work in other economic spheres (*cf.* the shepherd of the *lawagetas*), while the very title *te-re-ta*, from τέλη "services due" or τέλος "burden of service," possesses similar such allusion to palatial obligations. Given the vagueness of the nature of *te-re-ta* service in contrast to that of the professionals, it would be reasonable to surmise that the *te-re-ta* held an early claim of land, which was later acknowledged by the state, while those with an explicit professional service obligation were awarded palatial land grants. In either case–by acknowledging the legality of a prior claim or by awarding private land tenure rights from palatial holdings–the state ensures an indebtedness inherent in landedness.

With the creation of debt, the palace could coerce the highly cost effective transaction recorded in the E-series. Rather than taking on the expense of a religious event at which community and sanctuary participants are rewarded with gifts of grain/viatica, they could compel those with landed wealth, including the *da-mo*, to distribute their own surplus to the same such ends. In this way they spared themselves the expenditure but maintained social proximity and sponsorship credit. As instruments in the redistributive program, local landowners also gained a social advantage. They were, formally, the benefactors of individual participants and would have naturally reinforced their personal esteem. Indeed the *da-mo* collectively assumed the mantle of benefactor as well, but it did not individuate key players or contributors, which at this time would have been a major driver of conspicuous spending and euergetism. The obligation of liturgical spending, therefore, was evenly distributed across private and communal properties, but its social benefits were reaped by the individuals named in each line entry of the archival documents. Both the collectivist farmers and the local administrative organization were thus denied access to the theater of social performance; the

farmers had neither the means nor the need to parlay food sharing institutions (feasting) into displays of wealth inequality (hosting feasts) as the landowners must have done, since they neither controlled their own surplus nor needed to coerce a labor force periodically. Likewise the *da-mo*, while acquiescing to the liturgical obligation, would not be identified as wealthy benefactors, since the grain disbursement was not a personal expense in any respect.

A disparity such as this would have institutional ramifications, and may have seeded the third vulnerability. The functionality and longevity of the *ke-ke-me-na* sharing institutions were predicated on every resource user opting in, complying with rules and prohibitions that require short term sacrifice in the interest of long-term *collective* gain. When one can see members of the greater community grow wealthy, individuated, famous, and powerful while they themselves and their local leaders remain static, the personal cost of collective gain might become harder to bear. What once seemed bountiful, jovial, and safe might then seem spartan and punitive. As a result, the authority of local administrators is undermined.

In both cases, both with the forest management institutions and the communal farming program, community-based institutions developed that afforded communities regulated access privileges and the potential for resource longevity, even under the mounting pressure of demographic growth. Valuable oak wood was protected from over-extraction and deforestation by means of socially enforced procurement rules, and community land holdings were perhaps subject to entirely pooled labor and pooled benefits. The palace, either by co-opting the oak-specific institutions– making a special exemption for itself–or by subverting them altogether, guaranteed their own material gains and legitimized their own authority. Additionally, by means of either granting private land holdings to elite individuals or by acknowledging the legality of their earlier claims, the palace likewise profits. They acquired the means to mobilize the wealth of the private landholders such as the *damos*, and they destabilized village order. Perhaps the conspicuous surplus and heightened status of the private landholders tugged at the seams of the community sharing directives, inciting jealousy and eventually noncompliance. Ultimately, the state inserted itself into various fields of power, undermining the loci of resource governance and redeploying the long-held sharing institutions in a way that, in fact, disrupted their efficacy. The autonomy of settlement communities as well as communities of resource users was fundamentally destabilized, neutralizing threats to palatial authority, and as a consequence the palace was able to efficiently craft statist capital by reappropriating the very institutions that supported those they subjugated.

BIBLIOGRAPHY:

Accorsi, A.M., Bandini Mazzanti, C.A., Bosi, M., Trevisan Grandi, G., Cardarelli, A., Labate, D., Olmi, L., & Torri, P. (2006). "Cereal fields from the Middle-Recent Bronze Age, as found in the Terramara di Montale, in the Po Plain (Emilia Romagna, Northern Italy), based on pollen, seeds/ fruits and microcharcoals," in J-P Morel, J.T. Juan, & J.C. Matamala (Eds.), *The Archaeology of Crop Fields and Gardens* (pp. 251–270). Edipuglia.

Adler, M.A. (1996). "Land Tenure, Archaeology, and the Ancestral Pueblo Social Landscape," in *Journal of Anthropological Archaeology*, *15*(4), 337–371.

Adrados, F.R. (1956). "El Culto Real in Pilos ya la Distribucion de la tierra en Época Micénica," in *Emerita, 24*, 353–415.

Adrados, F.R. (1970). "*Te-re-ta wa-na-ka-te-ri* y los ἀνακτοτελέσται," in *Minos, 10*, 138–150.

Agrawal, A., & Ribot, J. (2014). "Are Ostrom's Design Principles Sufficient for Design?" in *Policy Matters, 19*(April), 111–15.

Alston, E., Alston, L.J., Mueller, B., & Nonnenmacher, T. (2018). *Institutional and Organizational Economics: Concepts and Applications*. Cambridge University Press.

Altman, J., Hedl, R., Szabo, P., Mazurek, P., Riedl, V., Mullerova, J., Kopecky, M., & Dolezal, J. (2013). "Tree-Rings Mirror Management Legacy: Dramatic Response of Standard Oaks to Past Coppicing in Central Europe," in *PLOS One*, *8,* e55770.

Asouti, E., Kabukcu, C., White, C., Kuijt, I., Finlayson, B., & Makarewicz, C. (2015). "Early Holocene woodland vegetation and human impacts in the arid zone of the southern Levant," in *The Holocene*, *25*, 1565–1580.

Aura Jorro, F. (1985), *Diccionario micenico* 1. Madrid: C.S.I.C.

Bachhuber, C. (2006). "Aegean Interest on the Uluburun Ship," in *American Journal of Archaeology*, *110*(3), 345–363.

Baden-Powell, B.H. (1898). "The Origin of Village Land-Tenures in India," in *The Journal of the Royal Asiatic Society of Great Britain and Ireland*, 605–616.

Barroso, L.R., & Mello, P.R.C. (2021). "In Defense of the Amazon Forest: The Role of Law and Courts," in *Harvard International Law Journal, 62.*

Bass, G.F., Throckmorton, P., Du Plat Taylor, J., Hennessy, J.B., Shulman, A.R., & Buchholz, H.G. (1967). "Cape Gelidonya: A Bronze Age Shipwreck," in *Transactions of the American Philosophical Society*, *57*(8), 1–177.

Bass, G.F. (1986). "A Bronze Age Shipwreck at Ulu Burun (Kaş): 1984 Campaign," in *American Journal of Archaeology*, *90*(3), 269–296.

Bates, R.H. (1988). "Contra Contractarianism: Some Reflections on the New Institutionalism," in *Politics & Society*, *16*(2-3), 387–401.

Batto, B.F. (1980). "Land Tenure and Women at Mari," in *Journal of the Economic and Social History of the Orient*, *23*(3), 209–239.

Bauslaugh, R.A. (1979). "The Text of Thucydides IV 8.6 and the South Channel at Pylos," in *The Journal of Hellenic Studies*, *99*, 1–6.

Bendall, L. (2003). "A Reconsideration of the Northeastern Building at Pylos: Evidence for a Mycenaean Redistributive Center," in *American Journal of Archaeology*, *107*(2), 181–231.

Bendall, L. (2004). "Fit for a King? Hierarchy, Exclusion, Aspiration and Desire in the Social Structure of Mycenaean Banqueting," in P. Halstead & J.C. Barrett (Eds.), *Food, Cuisine and Society in Prehistoric Greece* (pp. 105–135). Oxbow Books.

Bennett, E.L. (1956). "The Landholders of Pylos," in *American Journal of Archaeology*, *60*(2), 103–133.

Bennett E.L. (1958). *The olive oil tablets of pylos. texts of inscriptions found 1955*. Seminario de Filología Clásica Universidad de Salamanca.

Bennet, J. (1995). "Space Through Time: Diachronic Perspectives on the Spatial Organization of the Pylian State," in R. Laffineur & W.-D. Niemeier (Eds.), *Politeia: Society and State in the Aegean Bronze Age. Proceedings of the 5th International Aegean Conference / 5e Rencontre égéenne international University of Heidelberg, Archäologisches Institut, 10-13 April 1994, Vol II* (pp. 587–602). Histoire de l'art et archéologie de la Grèce antique; Program in Aegean Scripts and Prehistory.

Bennet, J. (2008). "The Geography of the Mycenaean Kingdoms" in Y. Duhoux, & A. Morpurgo Davies (Eds.), *A Companion to Linear B: Mycenaean Greek Texts and Their World, Volume 1. Bibliothèque des Cahiers de l'Institut de linguistique de Louvain. Antiquité 120* (pp. 137–168). Louvain-la-Neuve.

Blegen, C.W. (1965). "Architectural Notes from Pylos", in *Χαριστήριον εις Ἀναστάσιον Κ. Ὀρλάνδον*, 117–125.

Blegen, C.W. & Rawson, M. (1966). *The Palace of Nestor at Pylos in Western Messenia, Vol. 1: The Buildings and Their Contents.* Princeton University Press.

Boserup, E. (1965). *The Conditions of Agricultural Growth.* Routledge.

Bottema, S. (1974). *Late quaternary vegetation history of northwestern Greece*. University of California Press.

Bottema, S. (1982). "Palynological investigations in Greece with special reference to pollen as an indicator of human activity," in *Palaeohistoria, 24*, 257–288.

Bottema, S. (1999). "Landscape Archaeology and Reconstruction of the Mediterranean Environment Based on Palynology," in P. Leveau, F. Treatment, K. Walsh, & G. Barker (Eds.), *The Archaeology of Mediterranean Landscapes 2: Environmental Reconstruction in Mediterranean Landscape Archaeology* (pp. 9–16). Oxbow Books.

Bourdieu, P. (1986). "The Forms of Capital," in J. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 241–58.). Greenwood.

Bourdieu, P. (1999). "Rethinking the state: Genesis and structure of the bureaucratic field." in G. Steinmetz (Ed.), *State/Culture: State-formation after the Cultural Turn* (pp. 53–75). Cornell University Press

Boyd, M. (2002). *Middle Helladic and Early Mycenaean Mortuary Practices in the Southern and Western Peloponnese.* BAR International Series 1676

Boyd, M. (2016). "Distributed Practice and Cultural Identities in the 'Mycenaean' Period," in B. Molloy (Ed.), *Of Odysseys and Oddities: Scales and Modes of Interaction Between Prehistoric Aegean Societies and their Neighbours* (pp. 385–410). Oxbow Books.

Bray, D.B., Merino-Pérez, L., Negreros-Castillo, P., Segura-Warnholtz, G., Torres-Rojo, J.M., & Vester, H.F.M. (2003). "Mexico's Community-Managed Forests as a Global Model for Sustainable Landscapes," in *Conservation Biology*, *17*(3), 672–677.

Braun-Blanquet, J. (1964). *Pflanzensoziologie: Grundzüge der Vegetationskunde.* Springer-Verlag.

Broodbank, C. (2000). *An Island Archaeology of the Early Cyclades*. Cambridge University Press.

Brown, W. (1956). "Land Tenure in Mycenaean Pylos," in *Historia: Zeitschrift Für Alte Geschichte*, *5*(4), 385–400.

Brown, P. and Podolefsky, A. (1976) "Population Density, Agricultural Intensity, Land Tenure, and Group Size in the New Guinea Highlands," in *Ethnology*, *15*, 211–238.

Burkert, W. (1985). *Greek Religion*. Harvard University Press.

Butzer, K.W. (1969). "Changes in the Land" (review of C. Vita-Finzi: The Mediterranean Valleys: Geological Changes in Historic Times)," in *Science*, *165*, 52–53.

Carlier, P. (1987). "A propos des *te-re-ta,*" in *Tractata Mycenaea, proceedings of the English International Colloquium on Mycenaean Studies*, 65–73.

Carothers, J.J. (1992). "The Pylian Kingdom: A Case Study of an Early State." [Doctoral dissertation, University of California, Los Angeles].

Carratelli, G.P. (1954). "La Decifrazione dei Testi Micenei," in *La Parola del Passato, 35*, 81–117.

Carroll, T.M., Ciscil, D.H., & Chisholm, R.K. (1979). "The Market as a Commons: An Unconventional View of Property Rights," in *Journal of Economic Issues, 13*(2), 605–27.

Cavanagh, W.G. and Mee, C. (1998). *A private place: death in prehistoric Greece*. Studies in Mediterranean Archaeology CXXV. Paul Åströms Förlag.

Chadwick, J. (1957) "Potnia," in *Minos, 5*, 117–129.

Chadwick, J. (1963). "The Two Provinces of Pylos," in *Minos,* 7, 125–141.

Chadwick, J. (1972). "The Mycenaean Documents," in W.A. McDonald & G.R. Rapp (Eds.), *The Minnesota Messenia Expedition: Reconstructing a Bronze Age Regional Environment* (pp. 100–116). University of Minnesota Press.

Chadwick, J. (1973). "The Geography of the Further Province of Pylos," in *American Journal of Archaeology*, *77*(3), 276–278.

Chadwick, J. (1976). *The Mycenaean World.* Cambridge University Press.

Chang, C. (1992). "Archaeological landscapes: the ethnoarchaeology of pastoral land use in the Grevena province of Greece," in J. Rossignol & L. Wandsnider(Eds.), *Space, Time, and Archaeological Landscapes* (pp. 65–89). Springer.

Cherry, J.F. (1977). "Investigating the Political Geography of an Early State by Multidimensional Scaling of Linear B Tablet Data," in J. Bintliff (Ed.), *Mycenaean Geography: Proceedings of the Cambridge Colloquium, September 1976* (pp. 76–83). British Association for Mycenaean Studies.

Christakis, K. (2008). "Storage Behaviors and Subsistence Autarkies in the Non Palatial Sector of LM I Societies," in *The Politics of Storage: Storage and Sociopolitical Complexity in Neopalatial Crete* (pp. 109–118). INSTAP Academic Press.

Christakis, K.S. (2011). "Redistribution and Political Economies in Bronze Age Crete," in *American Journal of Archaeology, 115*(2), 197–205

Cox, M., Arnold, G., & Tomas, S. (2010). "A Review of Design Principles for Community-Based Natural Resource Management," in *Ecology and Society, 15*(4).

Craddock, P.T. (1995). *Early Metal Mining and Production*. Smithsonian Institution Press.

Coase, R.H. (1937). "The Nature of The Firm," *Economica*, November 1937, 86–495.

Coase, R.H. (1960). "The Problem of Social Cost," in *Journal of Law and Economics, 3*(1), 1–44.

Coase, R.H. (1984). "The New Institutional Economics," in *Zeitschrift Für Die Gesamte Staatswissenschaft / Journal of Institutional and Theoretical Economics*, *140*(1), 229–231.

Constantinou, G. (1982). "Geological Features and Ancient Exploitation of the Cupriferous Sulphide Orebodies of Cyprus," in J.D. Muhly, R. Maddin, & V. Karageorghis, (Eds.), *Early Metallurgy in Cyprus 4000–500 B.C* (pp. 13–23). Nicosia.

Constantinou, G. (1992). "Ancient Copper Mining in Cyprus," in A. Marangou & K. Psillides, (Eds.), *Cyprus, Copper and the Sea* (pp. pp. 43–74). Nicosia.

Cosmopoulos, M. B. (2006). "The Political Landscape of Mycenaean States: A-pu$_2$ and the Hither Province of Pylos," in *American Journal of Archaeology*, *110*(2), 205–228.

Cosmopoulos, M.B. (2021). " The Monumental architecture of Iklaina," in *(Social) Place and Space in Early Mycenaean Greece,* International discussions in Mycenaean archaeology, October 5-8, 2016 in Athens. Wien, 273–282.

Cosmopoulos, M., Allen, S.E., Riebe, D.J., Ruscillo, D., Liston, M., & Shelton, C. (2019). "New accelerator mass spectrometry C14 dates from the Mycenaean site of Iklaina," in *Journal of Archaeological Science: Reports, 24*, 888–899.

Cripps, E.L. (2007). *Land Tenure and Social Stratification in Ancient Mesopotamia*. BAR International Series 1676.

Dabney, M. K., Halstead, P., & Thomas, P. (2004). "Mycenaean Feasting on Tsoungiza at Ancient Nemea," in *Hesperia: The Journal of the American School of Classical Studies at Athens, 73*(2), 197–215.

Dales, J. H. (1975). "Beyond the Marketplace," in *Canadian Journal of Economics, 8*(4), 483–503.

D'Alfonso, L., & Matessi, A. (2021). "Extracting Cohesion: Fiscal Strategies in the Hittite Staple Economy," in J. Valk & I. S. Marín (Eds.), *Ancient Taxation: The Mechanics of Extraction in Comparative Perspective* (pp. 128–159). NYU Press.

Dasgupta, P. (2005). "Common Property Resources: Economic Analytics," in *Economic and Political Weekly*, *40*(16), 1610–1622.

Davidson, D.A. (1971). "Geomorphology and Prehistoric Settlement of the Plain of Drama," in *Revue de Giomorphologie Dynamique*, *20*, 22–26.

Davidson, D.A. (1980). "Erosion in Greece during the First and Second Millen-nia B.C.," in R.A. Cullingford & D.A. Davidson (Eds.), *Timescales in Geomorphology* (pp. 143–158). Wiley.

Davis, J.L., Alcock, S.E., Bennet, J., Lolos, Y.G., & Shelmerdine, C.W. (1997). "The Pylos Regional Archaeological Project Part I: Overview and the Archaeological Survey," in *Hesperia: The Journal of the American School of Classical Studies at Athens*, *66*(3), 391–494.

Davis, J.L., & Stocker, S.R. (2006). "Early Helladic and Middle Helladic Pylos: the Petropoulos trenches and the pre-Mycenaean remains on the Englianos Ridge," in A. Philippa-Touchais, G. Touchais, S. Voutsaki, & J. Wright (Eds.), *Mesohelladica: la Grèce continentale au Bronze Moyen* (pp. 101–106). BCH Supplement 52.

Davis, J.L. & Bennet, J. (1999). "Making Mycenaeans: warfare, territorial expansion, and representations of the other in the Pylian kingdom," in *POLEMOS: Le Contexte Guerrier En Égée à L'Age Du Bronze*, *Aegeaum, 19*(1), 105–120.

Day, P. (2004)."Marriage and Mobility: Traditions and the Dynamics of the Pottery System in Twentieth Century East Crete," in P. Betancourt (Ed.), *Pseira VIII: The Archaeological Survey of Pseira Island Part 2*. INSTAP Academic Press. 105–142

De Polignac, F. (1995). *Cults, Territory, and the Origins of the Greek City-State* (J. Lloyd, Trans.). University of Chicago Press.

Deger-Jalkotzy, S. (1978). *E-qe-ta: zur Rolle des Gefolgschaftswesens in der Sozialstruktur mykenischer Reiche.* Verlag der österreichischen Akademie der Wissenschaften.

Del Freo, M. (2009). "Les obligations dans les listes de terrains de Pylos," in *Ktema, 34*, 33–50.

Demsetz, H. (1967). "Toward a Theory of Property Rights," in *American Economic Review, 57*(2), 347–59.

Dequech, D. (2003). "Cognitive and Cultural Embeddedness: Combining Institutional Economics and Economic Sociology," in *Journal of Economic Issues*, *37*(2), 461–470.

Dietler, M. & Hayden, B. (Eds.) (2001). *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*. Smithsonian Institution Press.

Dillon, M. P. J. (1997). "The Ecology of the Greek Sanctuary," in *Zeitschrift Für Papyrologie Und Epigraphik*, *118*, 113–127.

DiMaggio, P. (1990)."Cultural Aspects of Economic Action and Organization," in, R. Friedland & A.F. Robertson (Eds.), *Beyond the Marketplace* (pp. 113–136). Aldine de Gruyter.

DiMaggio, P. (1994)."Culture and Economy," in N. Smelser & R. Swedberg (Eds.), *The Handbook of Economic Sociology* (pp. 27–57). Princeton University Press.

DiMaggio, P. (1997). "Culture and Cognition," in *Annual Review of Sociology*, *23*, 263-87.

Duffy, D.C., & Meier, A.J. (1992). "Do Appalachian Herbaceous Understories Ever Recover from Clearcutting?" in *Conservation Biology*, *6*(2), 196–201.

Dufraisse, A. (2008). "Firewood management and woodland exploitation during the late Neolithic at Lac de Chalain (Jura, France)," in *Vegetation History and Archaeobotany, 17*, 199–210.

Duhoux, Y. (1976). *Aspects du vocabulaire économique mycénien (cadastre, artisanat, fiscalité)*. A.M. Hakkert.

Duhoux, Y. & Morpurgo Davies, A. (Eds.). (2008). *A Companion to Linear B: Mycenaean Greek Texts and Their World, Volume 1. Bibliothèque des Cahiers de l'Institut de linguistique de Louvain. Antiquité 120*. Louvain-la-Neuve/Dudley, MA.

Dunkel, G. (1981). "Mycenaean *ke-ke-me-na, ki-ti-me-na,*" in *Minos, 17*, 18–29.

Earle, T.K. & Ericson, J.E. (1977). “Exchange systems in archaeological perspective,” in *Exchange systems in prehistory* (pp. 3–12). Academic Press;

Earle, T.K. (1982). “Prehistoric economics and the archaeology of exchange,” in *Contexts for prehistoric exchange* (pp. 1–12). Academic Press

Efkleidou, K. (2020). “Looking for houses in the tombs: The evidence for house societies in the Mycenaean Argolid,” in M. Relaki & J. Driessen (Eds.), *OIKOS: Archaeological Approaches to* House Societies *in the Bronze Age Aegean* (*Aegis* 19) (pp. 289–308). Presses Universitaires de Louvain.

Eisma, D. (1964). "Stream Deposition in the Mediterranean Area in Historical Times," in *Nature, 203*, 1061.

Eggertsson, T. (1990). *Economic Behavior and Institutions*. Cambridge University Press.

Fairbairn, A. & Omura, S. (2005). “Archaeological Identification and Significance of ÉSAG (Agricultural Storage Pits) at Kaman-Kalehöyük, Central Anatolia,” in *Anatolian Studies, 55*, 15–23.

Finke, E.A.W. (1988). *Landscape Evolution of the Argive Plain, Greece: Paleoecology, Holocene Depositional History and Coastline Changes* [Doctoral dissertation, Stanford University].

Finklestein, I. & Perevolotsky, A. (1990). “Processes of Sedentarization and Nomadization in the History of Sinai and the Negev,” in *Bulletin of the American Schools of Oriental Research, 279*, 67–88.

Finley, M.I. (1957). “The Mycenaean Tablets and Economic History,” in *Economic History Review, 10*, 128–41.

Finne, M., Holmgren, K., Shen, C., Hu, H., Boyd, M., & Stocker, S., (2017). “Late Bronze Age climate change and the destruction of the Mycenaean Palace of Nestor at Pylos,” in *PLoS ONE, 12*(12), 1–18.

Finne, M., Holmgren, K., Sundqvist, H.S., Weiberg, E., & Lindblom, M. (2011) “Climate in the eastern Mediterranean, and adjacent regions, during the past 6000 years–A review,” in *Journal of Archaeol Science*, *38*, 3153–3173.

Fiorentino, G., Caracuta, V., Calcagnile, L., D’Elia, M., Matthiae, P., Mavelli, F., & Quarta, G.(2008). “Third millennium B.C. climate change in Syria highlighted by carbon stable isotope analysis

of 14C-AMS dated plant remains from Ebla," in *Palaeogeography, Palaeoclimatology, Palaeoecology, 266*, 51–58.

Forbes, H. (1995). "The Identification of Pastoralist Sites within the Context of Estate-Based Agriculture in Ancient Greece: Beyond the 'Transhumance versus Agro-Pastoralism' Debate," in *The Annual British School at Athens, 90*, 325–338

Forbes, H. A., & Koster, H. A. (1976). Fire, Axe, and Plow: Human Influence on Local Plant Communities in the Southern Argolid," in *Annals of the New York Academy of Sciences*, *268*(1), 109–126.

Foster, E. (1977). "The Flax Impost at Pylos and Mycenaean Landholdings," in *Minos* 16, 19–55

Fox, R.S. (2012). *Feasting Practices and Changes in Greek Society from the Late Bronze Age to Early Iron Age*. Archaeopress.

Frischmann, B. M., Marciano, A., & Ramello, G. B. (2019). "Retrospectives: Tragedy of the Commons after 50 Years," in *The Journal of Economic Perspectives*, *33*(4), 211–228.

Frischmann, B., Madison, M., & Strandburg, K. (Eds.) (2014). *Governing the Knowledge Commons*. Oxford University Press.

Furubotn, E.G., & Richter, R. (1997). *Institutions and Economic Theory: The Contribution of the New Institutional Economics*. The University of Michigan Press.

Furumark, A. (1954). "Agaische Texte in Griechischer Sprache," in *Eranos* 51, 52, 18–60.

Galanakis, Y. (2017). "A survey of Late Bronze Age funerary archaeology over the last 25 years in the central and southern Aegean," in *Archaeological Reports*, *64*, 85–101.

Galaty, M.L., Nakassis, D., & Parkinson W. A. (2016.). "Introduction" in D. Nakassis, M.L. Galaty, & W.A.Parkinson (Eds.), *Discussion and Debate: Reciprocity in Aegean Palatial Societies: Gifts, Debt, and the Foundations of Economic Exchange* (pp. 61–70). *Journal of Mediterranean Archaeology 29*(1).

Galaty, M.L., Lafe, O., Lee, W.E., & Tafilica, Z. (Eds.) (2013). *Light and Shadow: Isolation and Interaction in the Shala Valley of Northern Albania*. Monumenta Archeologica 28. Cotsen Institute of Archaeology Press.

Garcia, J.M.V., Navarrete, M.I.M., Saez, J.A.L., & Morencos, I.D. (2010). “Environmental impact of copper mining and metallurgy during the Bronze Age at Kargaly (Orenburg region, Russia),” in *Trabajados de Prehistoria, 67(2)*, 511–544.

Garelli, P. (1967). "Le probleme de la 'feodalite' assyrienne du XV' au XII' siecle av. J.-C.," in *Semitica, 17*, 5–21.

Gianguzzi, L., & Bazan, G. (2019). “The *Olea europaea* L. var. *sylvestris* (Mill.) Lehr. forests in the Mediterranean area,” in *Plant Sociology, 56*(2), 3–34.

Gibson, J. (1979). *The Ecological Approach to Visual Perception.* Houghton Mifflin.

Gimmi, U., Matthias, B., & Stuber, M. (2008). “Reconstructing Anthropogenic Disturbance Regimes in Forest Ecosystems: A Case Study from the Swiss Rhone Valley,” in *Ecosystems, 11*(1), 113–124.

Giraudi, C., Magny, M., Zanchetta, G., & Drysdale, R.N. (2011). “The Holocene climatic evolution of Mediterranean Italy: a review of the continental geological data,” in *The Holocene, 21*, 105–115

Hall, T.D. (2015). “The Ecology of Herding: Conclusions, Questions, Speculations,” in P.N. Kardulias, (Ed.), T*he Ecology of Pastoralism* (pp. 267–280). University Press of Colorado.

Halstead, P. (1999). Toward a Model of Mycenaean Palatial Mobilization,” in M.L. Galaty & W.A. Parkinson (Eds.), *Rethinking Mycenaean Palaces II* (pp. 66–73). Cotsen Institute of Archaeology Press at UCLA.

Halstead, P. (2011). “Redistribution in Aegean Palatial Societies. Redistribution in Aegean Palatial Societies: Terminology, Scale, and Significance,” in *American Journal of Archaeology*, *115*(2), 229–235.

Halstead, P. (2014). *Two Oxen Ahead: pre-mechanized farming in the Mediterranean.* Wiley Blackwell.

Halstead, P., & J. O’Shea (Eds.) (1989). *In Bad Year Economics: cultural responses to risk and uncertainty*. Cambridge University Press.

Halstead, P., & Isaakidou, V. (2004). "Faunal Evidence for Feasting: Burnt Offerings from the Palace of Nestor at Pylos." In P. Halstead & J.C. Barrett (Eds.), *Food, Cuisine and Society in Prehistoric Greece* (pp. 136–54). Oxbow Books.

Hardin, G. (1968). “The Tragedy of the Commons,” in *Science*, *162* (13), 1243-1248.

Harding, A.F. (2000). *European Societies in the Bronze Age*. Cambridge University Press.

Hastorf, C.A., & Foxhall, L. (2017). "The social and political aspects of food surplus," in *World Archaeology*, *49*(1), 26–39.

Heidegger, M. (1962). *Being and Time*. Blackwell Publishing.

Herzberg, R.Q. (2020). "Elinor Ostrom's *Governing the Commons*: Institutional Diversity, Self-Governance, and Tragedy Diverted," in *The Independent Review*, *24*(4), 627–636.

Hewitt, J.F. (1897). "The Communal Origin of Indian Land Tenures," in *The Journal of the Royal Asiatic Society of Great Britain and Ireland*, 628–641.

Hood, S. (1960). "*Tholos* Tombs of the Aegean," in *Antiquity, 34*, 166–176.

Hooker, J.T. (1980). *Linear B: An Introduction.* Bristol Classical Press.

Hope Simpson, R. (1981). *Mycenaean Greece*. Noyes Press.

Horden, P., & Purcell, N. (2000). *The Corrupting Sea: a study of Mediterranean History.* Blackwell Publishing.

Horvat I., Glavac V., & Ellenberg H. (1974). *Vegetation Sudosteuropas.* Geobotanica Selecta 4, Stuttgart.

Hruby, J. (2013). "Crafts, Specialists, and Markets in Mycenaean Greece. The Palace of Nestor, Craft Production, and Mechanisms for the Transfer of Goods," in *American Journal of Archaeology*, *117*(3), 423–427.

Hughes, J. (2011). "Ancient Deforestation Revisited," in *Journal of the History of Biology, 44*(1), 43–57.

Hughes, J. D., & J. V. Thirgood (1982). "Deforestation, Erosion, and Forest Management in Ancient Greece and Rome" *Journal of Forest History*, *26*(2), 60–75.

Hukkinen, J. (1998). "Institutions, Environmental Management and Long-Term Ecological Sustenance," in *Ambio*, *27*(2), 112–117.

Ingold, T. (1992). "Culture and the Perception of the Environment," in K.R. Gibson & T. Ingold (Eds.), *Bush Base, Forest Farm: Culture, Environment and Development* (pp. 39–56). Routledge.

Ingold, T. (1993). “The Temporality of the Landscape,” in *World Archaeology*, *25*(2), 152–174.

Jahns, S. (1993). “On the Holocene vegetation history of the Argive Plain (Peloponnese, southern Greece),” in *Vegetation History and Archaeobotany*, *2*(4), 187–203.

Jazwa, C.S., & Jazwa, K. A. (2017). “Settlement ecology in bronze age messenia,” in *Journal of Anthropological Archaeology*, *45*, 157–169.

Johnson, O.E.G. (1972). "Economic Analysis, the Legal Framework and Land Tenure Systems," *Journal of Law and Economics*, *15*, 259–276.

Johnson, R.N., & Libecap, G.D. (1982). “Contracting Problems and Regulation: The Case of Fishery,” in *American Economic Review, 72*(5), 1005–22.

Jones, R.E., & Photos-Jones, E. (2005). “Technical studies of Aegean Bronze Age wall painting: methods, results and future prospects,” in *British School at Athens Studies*, *13*, 199–228.

Kabukcu, C. (2018). “Identification of woodland management practices and tree growth conditions in archaeological fuel waste remains: a case study from the site of Çatalhöyük in central Anatolia, Turkey,” in *Quaternary International*, *463*, 282–297.

Kapsali, P. (2019). “Two Middle Bronze Age Pottery Kilns at Plasi, Marathon,” in *Athens University Review of Archaeology*, *2*, 19–63.

Kardulias, P.N. (2015). “Introduction: Pastoralism as an Adaptive Strategy,” in P.N. Kardulias, (Ed.), *The Ecology of Pastoralism* (pp. 1–15). University Press of Colorado.

Kaufman, B., & Scott, D. A. (2014). “Fuel Efficiency of Ancient Copper Alloys: Theoretical Melting Thermodynamics of Copper, Tin and Arsenical Copper and Timber Conservation in the Bronze Age Levant*,” in *Archaeometry, 57*(6), 1009–1024.

Killen, J.T. (1983). “PY An 1,” in *Minos, 18*, 71–79.

Killen, J.T. (2008). “Mycenaean Economy,” in Y. Duhoux & A. Morpurgo Davies (Eds.), *A Companion to Linear B: Mycenaean Greek Texts and Their World* (pp. 159–200). Bibliothèque des Cahiers de l'Institut de linguistique de Louvain. Antiquité 120.

Killen, J.T. (2015). "The Pylos Ta Tablets Revisited," in M. Del Freo (Ed.), *Economy and Administration in Mycenaean Greece: Collected Papers on Linear B*, *3* (pp. 709–712). CNR, Istituto di studi sul Mediterraneo antico.

Kirch, P.V. (1994). *The wet and the dry: irrigation and agricultural intensification in Polynesia*. University of Chicago Press.

Klyza, C.M., & Sousa D.J. (2007). *American Environmental Policy, 1990–2006: Beyond Gridlock.* MIT Press.

Konstantinidis, P., Chatziphilippidis, G., Triourlis, G., & Tsiontsis, A. (2002). "Taxonomy and ecology of plant communities of Quercus frainetto Ten. (Q. conferta Kit.) forests in Greece," in *Israel Journal of Plant Sciences, 50*(2),145–154.

Koster H.A., & Koster, J.B. (1976). "Competition or Symbiosis?: Pastoral Adaptive Strategies in the Southern Argolid, Greece," in M. Dimen & E. Friedl (Eds.), *Regional Variation in Modern Greece and Cyprus: Toward a Perspective on the Ethnography of Greece* (pp. 275–285). Annals of the New York Academy of Sciences.

Koulelis, P. P., & Petrakis, P. V. (2023). "Brief Overview of Greek Fir Radial Growth in Response to Climate and European Fir Budworm: Three Case Studies from Giona Mountain, Central Greece," in *Climate* 11(4), 78.

Kraft, J.C., Rapp, G.R., & Aschenbrenner, S.E. (1980) "Late Holocene Paleogeomorphic Reconstructions in the Area of the Bay of Navarino: Sandy Pylos," in *Journal of Archaeological Science,* 7, 187–210.

Lambert, S.D. (1997). *Rationes Centesimarum: Sales of Public Land in Lykourgan Athens*. Brill.

Lewartowski, K. (1995). "Mycenaean social structure: a view from simple graves," in R. Laffineur & W-D. Niemeier (Eds.), *POLITEIA. Society and state in the Aegean bronze age*. *Aegaeum* 12 (pp. 103–115). Université de Liège/University of Texas at Austin.

Lewy, H. (1942). "The Nuzian Feudal System," in *Orientalia*, *11*, 1–40.

Lejeune, M. (1972). "Le *damos* dans la société mycénienne," in *Mémoires de Philologie Mycénienne, 3*, 137–54.

Lejeune, M. (1974). "Analyse du dossier pylien Ea," in *Minos, 15*, 82–115.

Liddell, H.G., Scott, R., & Jones, H.S. (1996). *Greek-English Lexicon.* Oxford University Press.

Loy, W.G. (1970). *The Land of Nestor: A Physical Geography of the Southwest Peloponnese* (National Academy of Sciences, Office of Naval Research, Report No. 34), Washington, D.C.

Loy, W.G., & Wright Jr., H.E. (1972). "The Physical Setting," in W.A. McDonald & G.R. Rapp (Eds.), *The Minnesota Messenia Expedition: Reconstructing a Bronze Age Regional Environment* (pp. 36–66.). University of Minnesota Press.

Lupack, S. (2008). *The Role of the Religious Sector in the Economy of the Late Bronze Age Mycenaean Greece.* BAR International Series 1858.

Lupack, S. (2011). "Redistribution in Aegean Palatial Societies. A View from Outside the Palace: The Sanctuary and the Damos in Mycenaean Economy and Society," in *American Journal of Archaeology, 115*, 207–217.

Lupack, S. (2015). "The Ea Series: It takes a Village," in *Aegean Scripts. Proceedings of the 14th International Colloquium on Mycenaean Studies, Copenhagen*, 2–5.

Lyttkens, C.H. (1997). "A Rational-Actor Perspective on the Origin of Liturgies in Ancient Greece," in *Journal of Institutional and Theoretical Economics (JITE) / Zeitschrift Für Die Gesamte Staatswissenschaft*, *153*(3), 462–484.

Manning, R. (2004). "Against the Grain: A Portrait of Industrial Agriculture as a Malign Force," in *The American Scholar*, *73*(1), 13–35.

Marazzi, M. (2008). "Messa a coltura e procedure di gestione e controllo dei campi nell' Anatolia hittita: caratteristiche della documentazione e stato della ricerca," in M. Perna & F. Pomponio (Eds.), *The Management of Agricultural Land and the Production of Textiles in the Mycenaean and Near Eastern Economies* (pp. 63–88). De Boccard.

Margaritis, E., Soles, J. S., Carter, T., Cutler, J., Doudalis, G., Faulmann, D., Flood, J. M., Giumlia-Mair, A. R., Hussein, A. M., Kaiser, L., Krzyszkowska, O., Morrison, J., Mylona, D., Ntinou, M., Papayianni, K., Stos-Gale, Z., & Westlake, P. (2022). "Palaeobotany: Cultivation and Agricultural Practices," in J.S. Soles & C. Davaras (Eds.), *Mochlos IVA: Period III. The House of the Metal Merchant and Other Buildings in the Neopalatial Town* (pp. 473–486). INSTAP Academic Press.

Marlon, J., Bartlein, P.J., Gavin, D.G., Long, C.J., Anderson, R.S., Briles, C.E., Brown, K.J., Colombaroli, D., Hallett, D.J., Power, M.J., Scharf, E.A., & Walsh M.K. (2012). "Long-term Perspective on Wildfires in the Western USA," in *Proceedings of the National Academy of Sciences, 109*(9), 535–543.

Marston, J.M., Kovacik, P., & Schoop, U.D. (2021). "Environmental reconstruction and wood use at Late Chalcolithic camlibel Tarlasi, Turkey," in *Quaternary International*, *593,* 178–194.

Marston, J.M. (2009). "Modeling wood acquisition strategies from archaeological charcoal remains," in *Journal of Archaeological Science, 36*, 2192–2200.

Mazarakis-Ainian, A. (1989). "Late Bronze Age Apsidal and Oval Buildings in Greece and Adjacent Areas," in *The Annual of the British School at Athens*, *84*, 269–288.

McDonald, W.A., & Rapp, G.R. (Eds.) (1972). *The Minnesota Messenia Expedition: Reconstructing a Bronze Age Regional Environment*. University of Minnesota Press.

McDonald, W.A., & Hope Simpson, R. (1972). "Archaeological Exploration" in W.A. McDonald & G.R. Rapp (Eds.), *The Minnesota Messenia Expedition: Reconstructing a Bronze Age Regional Environment* (pp. 117–147). University of Minnesota Press.

McDonald, W.A., Shay, C.T., Wilkie, N., Simpson, R.H., William D.E., Coulson, Donovan, W.P., Blitzer, H., Rosser, J., Donovan, W.P., Aschenbrenner, S., Howell, R.J., Dickinson, O.T.P.K., Hughes-Brock, H., Wade, W.D., Wolberg, D.L., Grady, F.V., Sloan, R. E., Shay, J., Rapp, G., & McDonald, W.A. (1975). "Excavations at Nichoria in Messenia: 1972-1973," in *Hesperia: The Journal of the American School of Classical Studies at Athens*, *44*(1), 69–141.

Mee, C.B., & Cavanagh, W. (1984). "Mycenaean Tombs as Evidence for Social and Political Organisation," in *Oxford Journal of Archaeology, 3*(3), 45–64.

Meiggs, R. (1982). *Trees and Timber in the Ancient Mediterranean World*. Oxford University Press.

Menard, C., & Shirley, M.M. (Eds.) (2005). *Handbook of New Institutional Economics*. Springer.

Michon, G., Nasi, R., & Balent, G. (2013). "Public Policies and Management of Rural Forests Lasting Alliance or Fool's Dialogue?" In *Ecology and Society, 18*(1), 1–12.

Miller, T.L. (2019). *Plant Kin: A Multispecies Ethnography in Indigenous Brazil*. University of Texas Press.

Monroe, C.M. (2007). "Vessel Volumetrics and the Myth of the Cyclopean Bronze Age Ship," in *Journal of the Economic and Social History of the Orient*, *50*(1), 1–18.

Monroe, C. M. (2010). "Sunk Costs at Late Bronze Age Uluburun," in *Bulletin of the American Schools of Oriental Research*, *357*, 19–33.

Morris, S. (2016). “Reciprocity: a response,” in D. Nakassis, M.L. Galaty, & W.A.Parkinson (Eds.), *Discussion and Debate: Reciprocity in Aegean Palatial Societies: Gifts, Debt, and the Foundations of Economic Exchange* (pp. 111–118). *Journal of Mediterranean Archaeology, 29*(1).

Nakassis, D. (2012). "Prestige and Interest Feasting and the King at Mycenaean Pylos," in *Hesperia: The Journal of the American School of Classical Studies at Athens, 81*(1), 1–30.

Nakassis, D. (2013). *Individuals and Society in Mycenaean Pylos.* Brill.

Nakassis, D. (2015). “Labor and Individuals in Late Bronze Age Pylos,” in P. Steinkeller & M. Hudson (Eds.), *Labor in the Ancient World* (pp. 583–615). ISLET-Verslag.

Nakassis, D. (2021). “The Extractive Systems of the Mycenaean World,” in J. Valk & I. S. Marín (Eds.), *Ancient Taxation: The Mechanics of Extraction in Comparative Perspective*, *11* (pp. 93–127). New York University Press.

Nakassis, D. (2022). “Communities, ‘houses’, and political organisation in the Mycenaean world,” in J.C.M. García (Ed.), *From House Societies to States: Early Political Organisation, From Antiquity to the Middle Ages*, *3* (pp. 123–140). Oxbow Books.

Nakassis, D., Parkinson, W.A., & Galaty, M.L. (2011). “Redistributive Economies from a Theoretical and Cross- Cultural Perspective,” in *American Journal of Archaeology, 115*(2),177–84.

Nash, R. (2001). *Wilderness and the American Mind* (4th edition). Yale University Press.

Nelson, M.C. (2001). *The Architecture of Epano Englianos, Greece*. [Doctoral dissertation, University of Toronto].

Netting, R.E. (1986). *Cultural Ecology* (2nd edition). Waveland Press.

Nie, M. (2008). *The Governance of Western Public Lands.* University Press of Kansas.

Nikoloudis, S. (2012). “Thoughts on a Possible Link between the PY Ea Series and a Mycenaean Tanning Operation,” in *Études mycéniennes 2010*, 285–300.

Nikoloudis, S. (2014). “Working the Land: Ka-ma Plots at Pylos,” in D. Nakassis, J. Gulizio, & S. James (Eds.), *KE-RA-ME-JA: Studies Presented to Cynthia W. Shelmerdine* (pp. 223–238). INSTAP Academic Press.

North, D.C. (1990). *Institutions, Institutional Change, and Economic Performance.* Cambridge University Press.

Oberlack, C., Walter, P.L., Schmerbeck, J., & Tiwari, B.K. (2015). "Institutions for sustainable forest governance: Robustness, equity, and cross-level interactions in Mawlyngbna, Meghalaya, India," in *International Journal of the Commons*, *9*(2), 670–697.

Olson, M. (1965). *The Logic of Collective Action*. Harvard University Press.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge University Press.

Ostrom, E. (1998). "A Behavioral Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association, 1997," in *American Political Science Review, 92*(1), 1–22.

Ostrom, E. (2007). "A Diagnostic Approach for Going beyond Panaceas." *PNAS 104*(39), 15181–87.

Ostrom, E. (2009). "A General Framework for Analyzing Sustainability of Social-Ecological Systems," in *Science*, *325*(5939), 419–422.

Osuna, J., Baldocchi, D., Kobayashi, H., & Dawson, T. (2015). "Seasonal trends in photosynthesis and electron transport during the Mediterranean summer drought in leaves of deciduous oaks," in *Tree physiology*, *35*(5), 485–500.

Paglione, G. (2023, January). "Building Roads in the Kingdom of Nestor? Some thoughts on the role of *to-ko-do-mo* in PY An 35 [paper presentation]," at AIA/SCS Joint Annual Meeting, New Orleans, LA.

Palaima, T.G. (1991). "Maritime Matters in the Linear B Tablets," in R. Laffineur & L. Basch (Eds.), *THALASSA: L'Égee prehistorique et la mer. Actes de la troisième Rencontre égéenne internationale de l'Université de Liège, Sta- tion de recherches soumarines et océanographiques (StaReSO), Calvi, Corse (23–25 avril 1990)* (pp. 273–310). *Aegaeum* 7. Université de Liège and University of Texas at Austin.

Palaima, T.G. (2000). "*Qémiv in the Mycenaean lexicon and the etymology of the place-name* *ti-mi-to a-ko," in *Faventia, 22*, 7–19.

Palaima, T.G. (2004)."Sacrificial Feasting in the Linear B Documents," in J.C. Wright (Ed.), *The Mycenaean Feast* (pp. 97–126). American School of Classical Studies at Athens.

Palmer, L.R. (1954). "Mycenaean Greek Texts from Pylos," in *Transactions of the Philological Society, 53,* 18–53.

Palmer, L.R. (1963). *The Interpretation of Mycenaean Greek Texts*. Oxford University Press.

Parisi, F., Schulz, N., & Depoorter, B. (2005). "Duality in Property: Commons and Anticommons," in *International Review of Law and Economics, 25*(4), 578–91.

Pearsall, D.M. (2015). *Paleoethnobotany: A Handbook of Procedures* (3rd Edition). Left Coast Press.

Pichler, T., Nicolussi, K., Goldenberg, G., Hanke, K., Kovács, K., & Thurner, A. (2013). "Charcoal from a prehistoric copper mine in the Austrian Alps: dendrochronological and dendrological data, demand for wood and forest utilisation," in *Journal of Archaeological Science, 40*(2), 992–1002.

Pluymers, K. (2021). *No Wood, No Kingdom: political ecology in the English Atlantic.* University of Pennsylvania Press.

Polanyi, K. (1960). "On the Comparative Treatment of Economic Institutions in Antiquity with Illustrations from Athens, Mycenae, and Alalakh." In C.H. Kraeling & R.M. Adams (Eds.), *City Invincible: A Symposium on Urbanization and Cultural Development in the Ancient Near East Held at the Oriental Institute of the University of Chicago, December 4–7, 1958* (pp. 329–50). The University of Chicago Press.

Polunin, O. (1980). *Flowers of Greece and the Balkans, a field guide*. Oxford University Press.

Postgate, J.N. (1971). "Land Tenure in the Middle Assyrian Period: A Reconstruction," in *Bulletin of the School of Oriental and African Studies, University of London*, *34*(3), 496–520.

Privitera, S. (2014). "Long-Term Grain Storage and Political Economy in Bronze Age Crete: Contextualizing Ayia Triada's Silo Complexes," in *American Journal of Archaeology*, *118*(3), 429–449.

Pulak, C. (1988). "The Bronze Age Shipwreck at Ulu Burun, Turkey: 1985 Campaign," in *American Journal of Archaeology*, *92*(1), 1–37.

Purcell, N. (2012). "Rivers and the geography of power," in *Pallas, 90*, 373–87.

Purcell, N. (2017). "Mountain margins: power, resources and environmental inequality in Antiquity," in S. von Reden, (Ed.), *Économie et inégalité: ressources, échanges et pouvoir dans l'Antiquité classique*, *Entretiens de la Fondation Hardt* 63. Geneva, 75–114.

Relaki, M., & D. Catapoti (Eds.) (1981). *An archaeology of land ownership*. Routledge/Taylor & Francis Group.

Renfrew, C., & Shennan, S. (Eds.) (1982). *Ranking, resource and exchange: aspect of the archaeology of early European society*. Cambridge University Press.

Robinson, L.W. (2019). "Open property and complex mosaics: Variants in tenure regimes across pastoralist social-ecological systems," in *The Commons Journal*, *13*(1), 804–826.

Rowan, E. (2015). "Olive Oil Pressing Waste as a Fuel Source in Antiquity," in *American Journal of Archaeology*, *119*(4), 465–482.

Rowton, M.B. (1973)."Urban Autonomy in a Nomadic Environment," in *Journal of Near Eastern Studies, 32*, 202-203.

Ruipérez, M.S. (1957). "Notes on Mycenaean Land- Division and Livestock-Grazing," in *Minos,* 5, 174–206.

Rutter, J. (1993). "Early Helladic Pottery: Inferences about Exchange and Production from Style and Clay Composition," in C. Zerner, P. Zerner, & J.Winder (Eds.), *Wace and Blegen: Pottery are Evidence for Trade in the Aegean Bronze Age*, *1939-1989* (pp. 39–56). Amsterdam.

Sauvage, C. (2017). "The development of maritime exchange in the Bronze Age Eastern Mediterranean," in P. De Souza, P. Arnaud, & C. Buchet (Eds.), *The Sea in History - The Ancient World* (pp. 151–164). Boydell & Brewer.

Schon, R. (2011). "By Appointment to His Majesty the *Wanax*: Value-Added Goods and Redistribution in Mycenaean Palatial Economies," in *American Journal of Archaeology, 115*(2):219–27

Scott, A.D. (Host). (2020, September 21). The Ancient Forest (No. 2) [Audio Podcast Episode] in *Timber Wars.* Oregon Public Broadcasting.

Shastry, B.S. (1988). "Land-Holdings under the *Communidades* of Goa: An Historical Perspective," in *Proceedings of the Indian History Congress, 1988, 49*, 411–419.

Shelmerdine, C.W. (1981). "Nichoria in Context: A Major Town in the Pylos Kingdom," in *American Journal of Archaeology*, *85*(3), 319–325.

Shelmerdine, C. (1985). *The perfume industry of Mycenaean Pylos*. P. Åströms Förlag.

Shelmerdine, C.W. (2011). "The Individual and the State in Mycenaean Greece," in *Bulletin of the Institute of Classical Studies*, *54*(1), 19–28.

Shelton, K. (2010) "Citadel and settlement: a developing economy at Mycenae, the case of Petsas House," in D. Pullen. (Ed.), *Political Economies of the Aegean Bronze Age. Papers from the Langford Conference, 22-24 February 2007, Florida State University* (pp. 184–204). Oxbow Books.

Shelton, K. (2016). "Petsas House, Pottery Production, and the Mycenaean People in LH IIIA 2," in J. Driessen (Ed.), *RA-PI-NE-U. Studies on the Mycenaean World offered to Robert Laffineur for his 70th Birthday* (pp. 317–326). Aegis 10. Presses Universitaires de Louvain.

Singer, I. (1984). "The AGRIG in the Hittite Texts," in *Anatolian Studies*, *34*, 97–127.

Smelser, N., & Swedberg, R. (Eds.) (1994). "Introduction," in *The Handbook of Economic Sociology*. Princeton University Press.

Smith, M.E. (2004). "The archaeology of ancient state economies," in *Annu. Rev. Anthropol.*, *33*, 73–102.

Smith, R.J. (1981). "Resolving the Tragedy of the Commons by Creating Private Property Rights in Wildlife," in *Cato Journal, 1*, 439–468.

Sourvinou-Inwood, C. (1988). "Further Aspects of Polis Religion," in *AION (archeol), 10*, 259–274.

Sourvinou-Inwood, C. (1990). "What is *Polis* Religion?" in O. Murray & S. Price (Eds.), *The Greek City: From Homer to Alexander* (pp. 295–322). Clarendon Press.

Spencer, L.C. (2007). *Pottery technology and socio-economic diversity on the Early Helladic III to Middle Helladic II Greek mainland*. University College London.

Standish, A. (1613). *New Directions of Experience Authorized by the Kings Most Excellent Maiesty, as May Appeare, for the Planting of Timber and Firewood.* London.

Stara, K., Tsiakiris, R., & Wong, J. (2015). "Valuing Trees in a Changing Cultural Landscape: A Case Study from Northwestern Greece," in *Human Ecology, 43*(1), 153–167.

Stark, B.L., & Garraty, C.P. (2010). "Detecting marketplace exchange in archaeology: a methodological review," in *Archaeological approaches to market exchange in ancient societies*, 33–58.

Stocker, S.R. (2003). “Pylos Regional Archaeological Project, Part V: Deriziotis Aloni: A Small Bronze Age Site in Messenia,” in *Hesperia: The Journal of the American School of Classical Studies at Athens*, *72*(4), 341–404.

Stocker, S.R., & Davis, J.L. (2004). "Animal Sacrifice, Archives, and Feasting at the Palace of Nestor," in J.C. Wright (Ed.), *The Mycenaean Feast* (pp. 59–76). American School of Classical Studies at Athens.

Stöllner, T. (2003). "Mining and Economy – A Discussion of Spatial Organisations and Structures of Early Raw Material Exploitation,” in T. Stöllner, G. Körlin, G. Steffens, & J. Cierny (Eds.), *Man and Mining–Mensch und Bergbau: Studies in Honour of Gerd Weisgerber* (pp. 415–446), Bochum.

Svizzero, S., & Tisdell, C. (2017). “The Demise of the Únětice Culture due to the Reduced Availability of Natural Resources for Bronze Production (A Draft),” in *Economics, Ecology, and the Environment,* 262–289.

Tartaron, T.F. (2013). *Maritime Networks in the Mycenaean World.* Cambridge University Press.

Timpson, M. E., Lee, S. Y., Ammons, J. T., & Foss, J. E. (1996). “A Mineralogical Investigation of Soils Formed in Calcareous Gravelly Alluvium, Eastern Crete, Greece," in *Soil Science Society of America Journal, 60*, 299–308.

Turner, J. And Greig, J.R.A. (1975). “Some Holocene Pollen Diagrams from Greece,” in *Review of Palaeobotany and Palynology, 20,* 171–204.

Uchitel, A. (1998). *Near Eastern and Mycenaean Archives Compared*, [Doctoral Dissertation, University College, London].

Uchitel, A. (2005). “Land-Tenure in Mycenaean Greece and the Hittite Empire: Linear B Land-Surveys from Pylos and Middle Hittite Land-Donations,” in *Journal of the Economic and Social History of the Orient*, *48*(4), 473–486.

Udo, R.K. (1965). “The Disintegration of Nucleated Settlement in East Nigeria,” in *Geographical Review*, *55*, 53–67.

Valmin, N. (1938). *The Swedish Messenia Expedition*. Lund.

Valmin, N. (1953). “Malthi-epilog: Vorläufiger Bericht über die schwedische Ausgrabung in Messenien 1952,” in *OpAth, 1*, 29–46.

Veal, R. (2012). "From Context to Economy: Charcoal as an Archaeological Interpretative Tool, a Case Study from Pompeii 3rd c. B.C. to A.D. 79," in I. Schrufer-Kolb (Ed.), *More than Just Numbers: The Role of Science in Roman Archaeology. Journal of Roman Archaeology Supplementary Series 91*, (pp. 19–52). *Journal of Roman Archaeology*.

Veal, R. (2013). 'Fuelling ancient Mediterranean cities: a framework for charcoal research,' in W.V. Harris (Ed.), *The Ancient Mediterranean between Science and History* (pp. 37–58). Columbia Classical Studies Series, *39*.

Veal, R. (2017a). "The Politics and Economics of Ancient Forests: timber and fuel as levers of Greco-Roman control," in *Entretiens sur L'Antiquité Classique, 63*, 317–368.

Veal, R. (2017b). "Wood and Charcoal for Rome: towards and understanding of ancient regional fuel economics," in T. de Haas & G. Tol (Eds.) *The Economic Integration of Italy: Rural Communities in a Globalizing World* (pp. 388–406). Brill.

Ventris, M., & J. Chadwick (1973). *Documents in Mycenaean Greek* (2nd Edition). Cambridge University Press.

Vita-Finzi, C. (1969). *The Mediterranean Valleys: Geological Changes in Historical Times*. Cambridge University Press.

Voutsaki, S. (1998). "Mortuary evidence, symbolic meanings and social change: a comparison between Messenia and the Argolid in the Mycenaean period," in K. Branigan (Ed.), *Cemetery and society in the Aegean Bronze Age* (pp. 41–58). Sheffield Studies in Aegean Archaeology.

Voutsaki, S. (2010). "From the kinship economy to the palatial economy: The Argolid in the second millennium BC," in D. Pullen (Ed.), *Political Economies of the Aegean Bronze Age* (pp. 89–111). Oxbow Books.

Voutsaki, S. (2016). "From Reciprocity to Centricity: The Middle Bronze Age in the Greek Mainland," in D. Nakassis, M. L. Galaty & W. A. Parkinson (Eds.), *Discussion and Debate: Reciprocity in Aegean Palatial Societies: Gifts, Debt, and the Foundations of Economic Exchange.* Journal of Mediterranean Archaeology 19(1), 70–78.

Wace, A.J.B. (1949). *MYCENAE: An Archeological History and Guide*. Princeton university press

Wachsmann, S. (1998). *Seagoing Ships and Seamanship in the Bronze Age Levant.* Texas A&M University Press

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). "Resilience, Adaptability and Transformability in Social–Ecological Systems," in *Ecology and Society*, *9*(2), Article 5.

Warburton, D. (2020)."Working," in D. Snell (Ed.), *A Companion to the Ancient Near East*, (2nd Edition) (pp. 181–200). Blackwell.

Webster, T.B.L. (1954). "Pylos *Aa, Ab,* tablets – Pylos *E* tablets – Additional Homeric Notes," in *Bulletin of the London Institute of Classical Studies, 1*, 11–16.

Weiberg, E., & Finne, M. (2018). "Resilience and persistence of ancient societies in the face of climate change: a case study from Late Bronze Age Peloponnese," in *World Archaeology, 50*(4), 584–602.

Welch, W.P. (1983). "The Political Feasibility of Full Ownership Property Rights: The Cases of Pollution and Fisheries," in *Policy Sciences*, *16*(2), 165–180.

Wertime, T.A. (1983). "The furnace versus the goat: the pyrotechnologic industries and Mediterranean deforestation in antiquity" in *Journal of Field Archaeology, 10*, 445–52.

Whitelaw, T. (2001). "From Sites to Communities: Defining the Human Dimensions of Minoan Urbanism," in K. Branigan (Ed.), *Urbanism in the Aegean Bronze Age* (pp. 5–37). Sheffield Academic Press.

Williamson, O. (1979). "Transaction Cost Economics: The Governance of Contractual Relations," in *Journal of Law and Economics*, *22*, 233–261.

Williamson, O. (1985). *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. The Free Press.

Williamson, O. (2000). "The New Institutional Economics: Taking Stock, Looking Ahead," in *Journal of Economic Literature*, *38*(3), 595–613.

Williamson, O., & Masten, S.E.(Eds.) (1999). *The Economics of Transaction Costs,* Edward Elgar Publishing.

Worsham, R., Lindblom, M., & Zikidi, C. (2018). "Preliminary report of the Malthi Archaeological Project, 2015–2016," in *Opuscula. Annual of the Swedish Institutes at Athens and Rome*, 11, 7–27.

Woodard, R.D. (2021). "Linear B *du-ma/da-ma*, Luvo-Hittite *Dammara-*, and Mycenaean Dialects," in MASt Summer Seminar 2021: summaries of presentations and discussions.

Wright, Jr., H.E. (1972). "The Vegetation History," in W.A. McDonald & G.R. Rapp (Eds.), *The Minnesota Messenia Expedition: Reconstructing a Bronze Age Regional Environment* (pp. 117–147). University of Minnesota Press.

Wright, J.C. (2004). "A Survey of Evidence for Feasting in Mycenaean Society" in *Hesperia: The Journal of the American School of Classical Studies at Athens*, *73*(2), 133–178.

Wright, J.C. (2006a). "The Formation of the Mycenaean Palace, in Ancient Greece," in S. Deger-Jalkotzy & I.S. Lemos (Eds.) *The Mycenaean Palaces to the Age of Homer* (pp. 7–52). Edinburgh Leventis Studies 3, Edinburgh University Press.

Wright, J.C. (2006b). "The Social Production of Space and the Architectural Reproduction of Society in the Bronze Age Aegean during the 2nd Millennium B.C.E.," in J. Maran, C. Juwig, H. Schwengel, & U. Thaler (Eds.), *Constructing Power: Architecture, Ideology and Social Practice* (pp. 49–69). Universitätsforschungen zur Prähistorischen Archäologie.

Wright, N.J. (2018). "Examining dendrological features of oak as possible signals of systematic woodland management in the central Anatolian bronze and iron ages," in *Quaternary International, 463*, 298–311.

Yassoglou, N.J., & Nobelli, C. (1972). "Soil studies," in W.A. McDonald & G.R.Rapp Jr. (Eds.), *The Minnesota Messenia expedition/ Reconstructing a Bronze Age regional environment* (pp. 171–176). The University of Minnesota Press.

Zangger, E., Timpson, M. E., Yazvenko, S. B., Kuhnke, F., & Knauss, J. (1997). "The Pylos Regional Archaeological Project: Part II: Landscape Evolution and Site Preservation," in *Hesperia: The Journal of the American School of Classical Studies at Athens*, *66*(4), 549–641.

Zerner, C.W. (1993). "New Perspectives on Trade in the Middle and Early Late Helladic Periods on the Mainland," in C. and P. Zerner & J.Winder (Eds.), *Wace and Blegen: Pottery are Evidence for Trade in the Aegean Bronze Age*, *1939-1989* (pp. 39–56). Amsterdam.

Zukin, S., & DiMaggio, P. (Eds.) (1990). *Introduction to Structures of Capital*. Cambridge University Press.