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# **Archaeology in Environment and Technology**

Intersections and Transformations

**Edited by David Frankel,  
Jennifer M. Webb  
and Susan Lawrence**

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## 8 Agricultural Economies and Pyrotechnologies in Bronze Age Jordan and Cyprus

Steven E. Falconer and Patricia L. Fall

### INTRODUCTION

The development of early civilisations in the eastern Mediterranean and Near East is particularly noteworthy for the variety of paths whereby agrarian societies became increasingly differentiated, often involving the periodic amalgamation and abandonment of urban communities. Following a deeply rooted intellectual tradition (e.g. Childe 1950; Smith 2009), scholars have long envisioned cities as the nuclei that integrated central places with each other and with the myriad villages that housed the majority of ancient populations. A comparison of Bronze Age communities in the Jordan Rift and on the island of Cyprus provides a perspective on emerging complex societies from an alternative vantage point focused on the interactions between farming communities, their managed environments and pyrotechnologies in distinctly non-urban social settings.

The late prehistory of both the southern Levant and Cyprus also fit well, but intriguingly differently, within the interpretive paradigm of the secondary products revolution (Sherratt 1981; Greenfield 2010). The Levantine Bronze Age featured the advent of towns and exchange of secondary products in Early Bronze II–III, their abandonment during Early Bronze IV and a dramatic rejuvenation of cities in the Middle Bronze Age (see Levy 1994). Over a roughly comparable time span, ancient Cypriot society witnessed intensified production of secondary goods through the Early and Middle Cypriot periods (e.g. Knapp 2008: 74–82; see also Webb, this volume), and towards the end of the Bronze Age the emergence of Late Cypriot urban markets and international exchange (Knapp 2008: 66–74, 131–59). Early/Middle Cypriot domestic evidence stems primarily from relatively few previously excavated communities, most notably Marki-Alonia (Frankel & Webb 1996, 2006), Sotira-Kaminoudhia (Swiny et al. 2003) and Alambra-Mouttes (Coleman et al. 1996). Our study takes advantage of these social and economic dynamics to compare roughly contemporaneous agrarian communities in distinctly different social, economic and environmental contexts (Table 8.1). Politiko-Troullia illustrates pre-urban life and landscape on Cyprus (see Webb 2009 and Frankel & Webb 2012a on households at

Table 8.1 Bronze Age chronologies for the southern Levant and Cyprus, showing general chronological relationships between Tell el-Hayyat, Tell Abu en-Ni'aj and Politiko-Troullia

Southern Levant	Date	Cyprus
Late Bronze urbanism	c. 1500 BC	Late Cypriot urbanisation
Middle Bronze re-urbanisation (Tell el-Hayyat)	c. 2000 BC	Middle Cypriot pre-urban (Politiko-Troullia)
Early Bronze IV urban collapse (Tell Abu en-Ni'aj)	c. 2400 BC	Early Cypriot pre-urban (Politiko-Troullia)
Early Bronze II–III urbanisation	c. 3000 BC	Chalcolithic pre-urban

Marki-Alonia), while Tell Abu en-Ni'aj and Tell el-Hayyat exemplify agrarian ruralism in the southern Levant during urban abandonment and redevelopment, respectively.

#### BRONZE AGE COMMUNITIES IN THE JORDAN RIFT AND CYPRUS

Tell Abu en-Ni'aj and Tell el-Hayyat embody the remains of Bronze Age farming villages in the *ghor*, the fertile agricultural lowlands just above the active stream channel of the Jordan River (Figure 8.1). These low mounds (3.5–4.5m high) lie only 1.5km apart at approximately 250m below sea level (Ibrahim et al. 1976: 51–4, sites 56 and 64). If their entire areas were occupied, population densities in traditional Middle Eastern villages (generally 200–250 people/ha, see e.g. Kramer 1982) suggest that Ni'aj (2.5ha) had 500 to 600 inhabitants, while Hayyat (0.5ha) housed 100 to 125 people. Tell Abu en-Ni'aj documents agrarian life during the abandonment of Levantine urbanism in Early Bronze IV (Falconer & Fall 2009). Excavated evidence stems from seven stratified phases of mud-brick houses and sherd-paved streets in the heart of the village and an apparent pressing installation on its eastern flank. Tell el-Hayyat illustrates village life amid re-urbanised society through the full course of the Middle Bronze Age (Falconer & Fall 2006). Hayyat features six phases of stratified stone and mud-brick architecture, including the sequential remains of four Canaanite

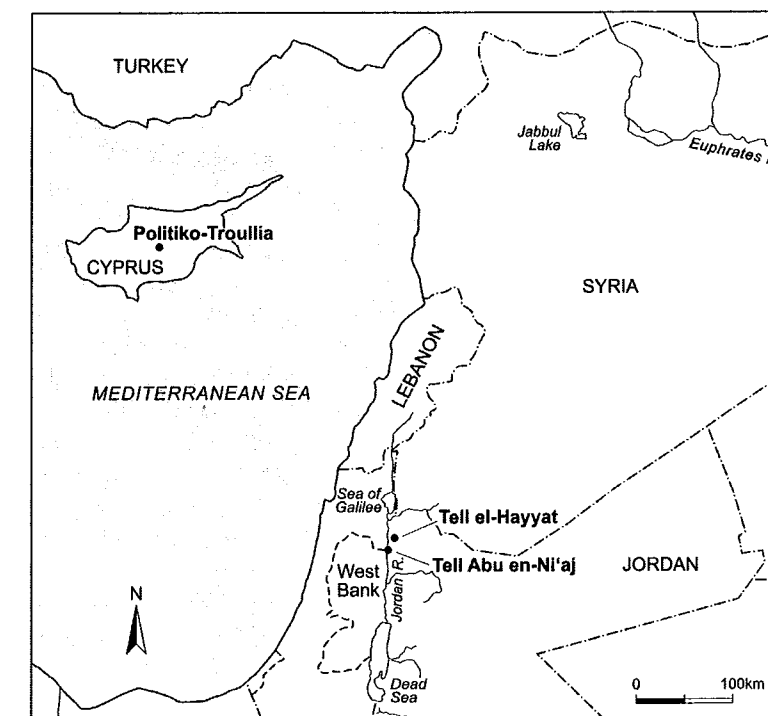


Figure 8.1 Map locating the Bronze Age settlements of Tell el-Hayyat and Tell Abu en-Ni'aj, Jordan, and Politiko-Troullia, Cyprus

temples and a well-preserved updraft pottery kiln built into the tell's southern slope.

Politiko-Troullia lies at the interface between the fertile Mesaoria Plain of central Cyprus and the copper-bearing Troodos Mountain foothills. Concentrated Bronze Age surface ceramics, plus clear signatures of buried architecture revealed by soil resistivity, indicate a settlement covering at least 2ha (Falconer et al. 2005). More than 3m of stratified remains document village life in the prehistoric Bronze Age (beginning late in the Early Cypriot period and continuing into the Middle Cypriot period; Falconer & Fall in press). Excavations in Politiko-Troullia East unearthed a compound of domestic structures and outbuildings associated with an exterior metallurgical workshop (Fall et al. 2008). Politiko-Troullia West, situated roughly 150m across the site, revealed two adjacent courtyards bounded on the south by a walled alleyway and its deeply stratified refuse-laden surfaces, and on the west, north and east by adjoining rooms. Spatial analysis of agricultural terracing and associated material culture on adjacent hillsides (covering approximately 20ha) infers long-term management of the surrounding landscape, most intensively during the prehistoric Bronze Age and Iron Age, with an apparent hiatus during the Late Cypriot advent of urbanism (Fall et al. 2012).



## AVENUES OF INFERENCE

This study compares patterns of animal exploitation, crop cultivation and pyrotechnological industry as they reveal interactions of society, environment and technology at Politiko-Troullia, Tell Abu en-Ni'aj and Tell el-Hayyat. While this evidence varies within sites both temporally and spatially, we concentrate here on overall inter-settlement patterns that provide robust comparisons between these communities in the Levant and Cyprus. The use of animal resources and associated implications for Levantine and Cypriot Bronze Age landscapes may be inferred from the animal bone assemblages recovered from these three settlements. All excavated sediments were screened through 0.5cm mesh screen. The resulting faunal data are presented as NISP (numbers of identified specimens), which provides the best means to compare relative frequencies of animal taxa across time or space (see e.g. O'Connor 2000: 55; Reitz & Wing 2008: 202–10). The bulk of the faunal remains comes from a relatively narrow range of husbanded domesticates: sheep (*Ovis aries*), goat (*Capra hircus*), cattle (*Bos taurus*) and pig (*Sus scrofa*). Wild species are represented at all three sites by minor amounts of wild birds, fish and small mammals, while Mesopotamian fallow deer (*Dama dama mesopotamica*) is found only at Politiko-Troullia.

Systematic water flotation of sediment from a variety of excavated contexts at Tell Abu en-Ni'aj, Tell el-Hayyat and Politiko-Troullia recovered carbonised botanical remains, including substantial remains of wood charcoal, indicative of crop cultivation, fuel consumption and local vegetation. All sediments showing evidence of charred organic content were sampled and analysed for botanical remains using manual, nonmechanised flotation procedures (see Klinge & Fall 2010). The major plant taxa represented in the floral assemblages from all three sites may be categorised as orchard taxa, cereals, legumes or wild and weedy taxa. Perennial orchard species are mainly olive (*Olea europea*), grape (*Vitis vinifera*) and fig (*Ficus carica*). Cultivated cereals are wheat (*Triticum* sp.), barley (*Hordeum* sp.), oat (*Avena* sp.) and rye (*Secale* sp.). Cultivated legumes include lentil (*Lens culinaris*), garden pea (*Pisum sativum*), chickpea (*Cicer arietinum*), fava bean (*Vicia faba*) and grass pea/bitter vetch (*Lathyrus sativus/Vicia ervilla*). The varieties of wild taxa include wild cereals (Poaceae), wild legumes (Papilionaceae) and *Prosopis*, as well as crop-following weeds (e.g. Asteraceae, *Galium*). These seed remains may be quantified as counts or weights, with seed counts expressed as relative frequencies for each taxon or category. Charcoal remains recovered via flotation are quantified most effectively by weight. Thus density values, reflecting the abundance of carbonised plant remains in flotation samples, are calculated as seed densities (# seeds/kl of processed sediment) and charcoal densities (g charcoal/kl of processed sediment).

Seed and charcoal data, accordingly, may be integrated through the use of seed:charcoal ratios (e.g. based on weights), which permit inference of

relative rates of seed vs. charcoal carbonisation. A variety of case studies suggest that ancient societies, particularly those incorporating intensive pyrotechnology (e.g. for metallurgy or firing pottery), tended to exhaust fuel wood sources and subsequently shift to dung fuel (Sillar 2000; Rhode et al. 2007). Ethnographic studies, in turn, reveal that seed carbonisation primarily indicates burning of dung fuel, especially in the domesticated animal economies of the ancient Mediterranean world (e.g. Miller 1996). Seed:charcoal ratios thus reflect varying combinations of fuel wood and dung fuel consumption in antiquity (Miller 1988), with attendant implications for the probable availability of woodland fuel sources.

Bronze Age agrarian society embarked on long-term intensification of previously established technologies. Across the rural landscapes of Cyprus and the Levant, farming communities invested considerable energy in constructing agricultural terraces and check dams to retain field plots and conserve precious soil and rainfall. Their remains demonstrate the ebb and flow of agricultural land use patterns. Within these settlements the use of fuel consumptive pyrotechnologies to produce ceramic containers and metal implements helped create distinctly anthropogenic surrounding landscapes. However, these technologies varied considerably in their material expression and environmental implications. Indeed, variability in all these forms of evidence provides the leitmotif of this study.

## ANIMAL MANAGEMENT AND CONSUMPTION

Animal husbandry and consumption at all three settlements focused heavily on domesticated sheep and goat as signalled clearly by bone counts in which *Ovis/Capra* constitute consistently sizable majorities (Table 8.2). The high value for sheep/goat at Tell el-Hayyat reflects, in part, the preference for ovicaprid offerings that were deposited within Hayyat's temple compounds (Falconer & Fall 2006: fig. 6.47). At the other end of the animal exploitation spectrum, the occupants of our two Levantine villages engaged in only negligible hunting and fishing, despite the persistence of the Jordan River as a source of fish and the Jordan Rift as an avian migratory flyway.

Among the remaining taxa, cattle bones found at all three sites indicate a minor component of beef consumption and the role of bovids for the traction needed for plough technology in surrounding fields. The relative frequencies for the remaining taxonomic categories vary widely between settlements, indicating strikingly divergent animal availability and exploitation in the Jordan Rift and Cyprus. At Hayyat and, most strikingly, at Abu en-Ni'aj swine clearly rank second among sources of animal remains. In both settings swine herding provides an attractive complement to sheep/goat herding, since pigs are prolific reproducers, grow quickly to mature meat weight and may be tended as backyard scavengers without the need for extensive pasturing (Zeder 1991: 30; Hesse 1995). On the other hand,

Table 8.2 Relative frequencies of identified bone fragments by animal taxon excavated from Tell Abu en-Ni'aj (Phases 6-1), Tell el-Hayyat (Phases 5-2) and Politiko-Troullia (latest phase in Troullia East and West). Data from Falconer et al. 2004; Falconer & Fall 2006: tables 5.3 and 5.4; Falconer & Fall in press

Taxon	Tell Abu en-Ni'aj	Tell el-Hayyat	Politiko-Troullia
Sheep/goat	60%	71%	68%
Pig	28%	17%	4%
Cattle	11%	12%	8%
Wild	<1%	<1%	20%
NISP	5180	11,970	3863

pigs have relatively high water needs, provide few secondary products and are poorly suited for herding to market (Horwitz & Tchernov 1989; Hesse 1995). Even at Hayyat, in the context of urbanised society, and especially at Ni'aj during urban collapse, pig husbandry appears to be a signature of localised nonmobile animal management in a village environment.

In stark contrast to their Levantine contemporaries, the villagers of Politiko-Troullia complemented their sheep/goat herding with ample exploitation of wild animals, most notably through hunting of Mesopotamian fallow deer (*Dama dama mesopotamica*). The importance of deer hunting emerges repeatedly at Early and Middle Cypriot communities elsewhere on Cyprus (Reese 1996; Croft 2003, 2006). This preference is especially pronounced in the generally domestic setting of Troullia West, particularly in its alleyway and southern courtyard (Falconer & Fall in press). Thus, while the villagers of the Rift bottomlands augmented the venerable tradition of sheep/goat herding with backyard pig husbandry, the occupants of Politiko-Troullia turned to a different supplement by hunting forest-dwelling cervids in the surrounding hill country.

#### CROP CULTIVATION AND FUEL CONSUMPTION

Relative frequencies of carbonised seeds, as with animal bones, reveal fundamental contrasts between cultivation strategies, especially as practised in the Jordan Rift and on Cyprus (Table 8.3). Cultivated cereals and their attendant crop-following weeds comprise roughly 80% of the relatively similar seed assemblages from Tell Abu en-Ni'aj and Tell el-Hayyat. Orchard taxa from these two sites, despite being preferred for temple offerings at Hayyat (Falconer & Fall 2006: fig. 6.46), contribute much more modestly. In stark contrast, the Politiko-Troullia floral profile is dominated overwhelmingly by perennial orchard taxa, with correspondingly much less evidence of wild or weedy taxa. Cereals are represented only modestly, and legumes, which contribute minimally to the array of crops cultivated by the

Table 8.3 Relative frequencies of identified seeds, seed and charcoal densities and seed:charcoal ratios for Tell Abu en-Ni'aj (Phases 6-1), Tell el-Hayyat (Phases 5-2) and Politiko-Troullia (latest phase in Troullia East and West). Data from Falconer et al. 2004; Falconer & Fall 2006: appendix E; Klinge & Fall 2010; Falconer & Fall in press

Taxon	Tell Abu en-Ni'aj	Tell el-Hayyat	Politiko-Troullia
Orchard	13%	17%	78%
Cereals	33%	30%	6%
Legumes	3%	4%	<1%
Wild/weedy	51%	49%	15%
Identified seeds	2217	8081	401
N samples	60	151	50
Seed density (#/kl)	192,885	16,257	1093
Charcoal density (g/kl)	485	2842	487
Seed:charcoal (g:g)	2.37	0.97	0.35

farmers of all three villages, are virtually absent at Politiko-Troullia. While the animal bone assemblages suggest somewhat different modes of herding and hunting at all three sites, the data for carbonised seeds portray similar profiles of crop cultivation around Abu en-Ni'aj and Hayyat while accentuating the differences between this valley-bottom farming and the emphasis on arboriculture in the Troodos foothills around Troullia.

Seed:charcoal ratios reveal somewhat more nuanced distinctions in fuel consumption at these three villages, thereby providing a first indication of differing configurations of vegetation availability, fuel consumption and pyrotechnological industry. These ratios produce relatively high values for Tell Abu en-Ni'aj, comparable to those from Bronze Age towns along the Euphrates in Syria (Klinge & Fall 2010). This points to relatively modest burning of fuel wood and heavier use of dung fuel at Abu en-Ni'aj and in the Syrian steppe. The extremely high mean seed density for Abu en-Ni'aj strengthens an interpretation of particularly pervasive reliance on dung fuel by its villagers. When coupled with lower orchard seed frequencies than found at Hayyat or Troullia, this evidence suggests Tell Abu en-Ni'aj occupied a largely deforested landscape with minimal availability of fuel wood, whether cut from wild stands or harvested from orchards.

At the other end of the floral spectrum, Politiko-Troullia produced the lowest overall seed:charcoal ratio, based on a low mean seed density and a charcoal density comparable to that from Abu en-Ni'aj. However, an abundance of charcoal deposited in and around the courtyard metallurgical workshop at Politiko-Troullia elevates the charcoal density for Troullia East to 1690g/kl and drops its seed:charcoal ratio to 0.11 (Klinge & Fall

2010), by far the lowest ratio considered in this study. If we incorporate this community's emphasis on arboriculture and the considerable availability of forest-dwelling fallow deer, a snapshot emerges of Politiko-*Troullia* at an ecotone between adjacent managed orchards and presumably nearby woodlands (and mineral resources), amid a very different kind of anthropogenic landscape than that found around Tell Abu en-Ni'aj.

Tell el-Hayyat is situated between Politiko-*Troullia* and Tell Abu en-Ni'aj in terms of mean seed:charcoal ratio and its attendant environmental implications. While Hayyat produced an intermediate seed density, its charcoal density is more than five times higher than those found at the other two settlements. Given its cereal-oriented crop profile, it seems clear that Hayyat's households implemented farming strategies similar to those of Abu en-Ni'aj, probably in a common nonforested local environment given the close proximity of the two sites. However, the charcoal evidence from both Tell el-Hayyat and Politiko-*Troullia* signals the importance of fuel-driven technologies as they impacted their surrounding landscapes. (Preliminary identifications indicate burning of olive wood at Hayyat and pine at *Troullia*.)

#### PYROTECHNOLOGIES IN THE COUNTRYSIDE

The importance of fuel-consumptive technology for community behaviour is manifested rather differently at Tell Abu en-Ni'aj, Tell el-Hayyat and Politiko-*Troullia*. Although neutron activation analysis suggests that Abu en-Ni'aj and other comparable villages may have produced the signature trickle-painted cups of Early Bronze IV (Falconer 1987), the units excavated at this site revealed no direct evidence of pottery manufacture or use of any other pyrotechnology beyond household fuel use. Indeed, the extremely high mean seed density, low charcoal density and correspondingly high seed:charcoal ratio for Abu en-Ni'aj suggest reliance on dung fuel for domestic needs with little connotation of industrial pyrotechnology.

In contrast to Abu en-Ni'aj, the high charcoal density and very low seed:charcoal ratio for Politiko-*Troullia* East underscore the local availability of firewood, a fuel source favoured for metallurgy over lower-firing animal dung (Forbes 1971; Bamberger & Wincierzt 1990). A roofed courtyard here with charcoal-laden sediments, remnants of a rudimentary furnace, a three-tool carved limestone mould, ceramic crucibles, tap slags and ore fragments suggests household-level industry for the production of utilitarian tools, such as the pins, needles and the dagger hilt found in the alleyway refuse of Politiko-*Troullia* West (Falconer & Fall in press).

The relatively modest seed:charcoal ratio and very high charcoal density (five times that of *Troullia* or Abu en-Ni'aj) signal the importance of pyrotechnology at Tell el-Hayyat, despite its situation in the apparently deforested bottomlands of the Jordan Valley. Here fuel-intensive technology finds multiple expressions: broad-range pottery production and metallurgy

involving manufacture of both offertory figurines and utilitarian tools. In addition to the largely intact kiln remains, ceramic wasters and over-fired pots, neutron activation analysis suggests production of cooking pots, storage jars and possibly fine ware bowls, despite Tell el-Hayyat's diminutive size (Falconer 1987). This pattern of pottery distribution stands in contrast to the largely localised production and consumption of pottery in Early and Middle Cypriot communities on Cyprus (Frankel & Webb 2012b).

While Hayyat does not reveal a discernible footprint for a workshop, its metallurgy is clearly multifaceted (Falconer & Fall 2006: 83–95). Although slag and ore fragments are less abundant, probably reflecting greater distances to ore sources than at Politiko-*Troullia*, ceramic crucibles and limestone moulds once produced both everyday tanged implements and anthropomorphic figurines. Interestingly, most manufacturing debris and especially finished metal objects were deposited in the forecourts or interiors of Hayyat's temples, as part of a multimedia array of offertory objects. Thus this element of Bronze Age technology provided a means of interaction not only with the fuel-bearing local environment, but also among the households and social institutions manifested by Hayyat's domestic enclosures and temple compounds.

#### CONCLUSION

The evidence from Tell el-Hayyat, Tell Abu en-Ni'aj and Politiko-*Troullia* supports a multifaceted portrait of agrarian communities enmeshed in various expressions of the secondary products revolution and in a variety of pre-urban, non-urban or re-urbanised social contexts. Rather than emphasising general similarities among the Bronze Age agrarian societies of Cyprus and the Jordan Rift as they relate to early urbanism (or the lack thereof), this study tends to accentuate the diversity of natural landscapes, plant and animal utilisation, pyrotechnologies and related modes of social interaction in these emerging complex societies. In overview, the villagers of Tell Abu en-Ni'aj practised dedicated sedentary farming on an apparently deforested landscape during a period often interpreted, ironically, in terms of nonsedentary pastoralism. In contrast, the inhabitants of Politiko-*Troullia* utilised a very different anthropogenic landscape of apparently intensive arboriculture in close proximity to nearby forest and mineral resources, which supported relatively expedient household metallurgy. Pyrotechnology plays rather different roles at Tell el-Hayyat, where the importance of utilitarian and especially ritual metallurgy inspired pronounced fuel wood consumption despite its location in an anthropogenic landscape similar to that of Abu en-Ni'aj. Thus, over a roughly common time span in the late third millennium and early second millennium BC, these three sedentary agrarian communities, each populated by no more than a few hundred villagers, illustrate the diversity of social, environmental and technological

interactions that characterised the foundations of early civilisation in the eastern Mediterranean.

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## 9 Changing Technological and Social Environments in the Second Half of the Third Millennium BC in Cyprus

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### INTRODUCTION

Two major archaeologically recognisable cultural entities are visible in mid-third millennium BC Cyprus: an indigenous Late Chalcolithic dependent on hoe-based agriculture and a migrant Philia Early Bronze Age with a radically different social and technological system, including the cattle/plough complex. This was a key point of disjunction in the prehistory of Cyprus, which offered a significant competitive advantage to the newcomers and presented a major adaptive challenge to the pre-existing population. This chapter examines the impact of what appears to have been a relatively sudden introduction of a suite of new technologies and seeks to identify and explain the processes involved in the interaction between Late Chalcolithic and Bronze Age communities and the eventual encompassing of one by the other. It views them as organisationally and ideologically distinct environments—with a focus not so much on the actual physical landscape as on the perceived or experienced environment constituted through previous history and specific cultural tradition and resulting from the constraints and opportunities provided by available technologies and social structures (see Butzer 1972). The incursive Philia system shaped new and divergent sets of material objects and social logics. In an attempt to explain these outcomes, this chapter adopts a contextual approach in order to identify response mechanisms and model the uptake and persistence of technologies and social strategies across the island.

The data examined relate to the latter years of the Late Chalcolithic (2700–2450/2400 BC) and the first phase of the Early Bronze Age (or EBA), known as the Philia Early Cypriot (hereafter EC) (2450/2400–2300/2250 BC). While the absolute chronology is in need of refinement, radiocarbon determinations suggest a significant temporal overlap between these two cultural phases.

### THE LATE CHALCOLITHIC/PHILIA EC TRANSITION

The Philia EC was a period of profound social, economic and technological transformation. Prominent amongst the changes visible at this time are