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## The Green, Green Grass of Home: an archaeo-ecological approach to pastoralist settlement in central Kenya

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### ABSTRACT

This paper considers the ecological residues of pastoralist occupation at the site of Maili Sita in Laikipia, central Kenya, drawing links with the archaeological record so as to contribute a fresh approach to the ephemeral settlement sites of mobile herding communities, a methodological aspect of African archaeology that remains problematic. Variations in the geochemical and micromorphological composition of soils along transects across the site are compared with vegetation distributions and satellite imagery to propose an occupation pattern not dissimilar to contemporary Cushitic-speaking groups further north. We argue that Maili Sita exemplifies the broad migratory and cultural exchange networks in place during the mid- to late second millennium AD, with pastoralist occupants who were both physically and culturally mobile.

### ABSTRAIT

Cet article examine les résidus écologiques d'une occupation pastoraliste sur le site de Maili Sita à Laikipia, au centre du Kenya. Nous établissons des liens avec les données archéologiques afin d'apporter une nouvelle approche à la question des sites éphémères des communautés pastorales mobiles, un aspect méthodologique de l'archéologie africaine qui reste problématique. Les variations dans la composition géochimique et micromorphologique des sols le long de transects sur le site de Maili Sita sont comparées avec la distribution de la végétation et avec l'imagerie satellite pour proposer un modèle d'occupation qui est comparable avec celui des groupes contemporains cushitiques se trouvant plus au nord. Nous soutenons que Maili Sita illustre les grands réseaux d'échange migratoires et culturels qui étaient en place dans la seconde moitié du deuxième millénaire ap. J.-C., avec des occupants pastoralistes qui étaient à la fois physiquement et culturellement mobiles.

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## Introduction

Issues of mobility, ranging from population migration, through generational changes in settlement, exchange networks and human biographies, to annual and seasonal

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movements of livestock, materials and people, have been prominent themes in archaeological reconstructions and interpretations of the material and biological records of pastoralism in eastern Africa. Spanning over four and a half to five thousand years of human, environment and non-human species interactions, the drivers, consequences and material and biochemical traces of these different kinds of mobility are inevitably varied and manifest themselves at different spatial and temporal scales. That these different forms and scales are in some sense related is often implicit in many studies, although for quite understandable and justifiable reasons there has been a tendency for analyses to focus on single categories of mobility (e.g. the role of population migration in the inception of livestock herding in the region, or the extent of seasonal movements of settlements and livestock) rather than striving for improved understanding of the interplay between these different scales and types. In common with archaeological studies in many other parts of the world, acknowledgement of the importance of mobility to different pastoralist systems, whether in terms of livelihoods, economic strategies and adaptive capacities, or with reference to symbolic constructions, has tended to go hand-in-hand with a conceptualisation of these different mobilities as presenting particular interpretative challenges. The greater difficulty of recognising the settlements and other activity traces of pastoralists (and for that matter also of hunter-gatherer-fishers) relative to those of agricultural populations precisely because of their mobility, for example, has been a major narrative trope in archaeological interpretations of pastoralism in the region and elsewhere on the African continent (see Lane 2016a for a fuller discussion).

While recognising and acknowledging that mobility (regardless of dominant subsistence strategy) can result in highly ephemeral material traces and therefore may limit archaeological visibility and inhibit certain lines of interpretation, we argue for the deployment of a wider range of approaches to the identification of pastoralist settlements rather than a simple reliance on artefactual evidence. We draw inspiration from a number of related recent archaeological and ecological studies (see below) to explore the biocultural significance of ecological indicators (see also Lane 2016b). More specifically, we discuss the notion that archaeologists interested in pastoralist societies, rather than searching for the kinds of material residues associated with sedentary economies — such as evidence of construction, dense refuse accumulations, etc. — and long-recognised as being diminished in the context of mobile groups (e.g. Childe 1936; Gifford 1978; Robertshaw 1978; Banning and Kohler-Rollefson 1992), might instead turn their attention to the ecological changes that such groups effect upon the environments they inhabit. Such impacts are considered here in the context of the semi-arid savanna grasslands of central Kenya, taking as a central case study the site of Maili Sita,<sup>1</sup> probably occupied some time between the mid-seventeenth and early eighteenth centuries AD.<sup>2</sup> Our second concern with African mobility uses the fruits of this archaeo-ecological approach to take a more sociological perspective, whereby we assess how ethnic, cultural and economic fluidity, as well as actual population movement, presaged the emergence of the well-defined identities that characterised the region into the colonial period. We begin by outlining the development and state of current thinking surrounding the position of pastoralism as a component of broader savanna ecologies and then move on to describe how these ideas have influenced our understandings of the occupation of Maili Sita and its relation to the broader social history of the region.

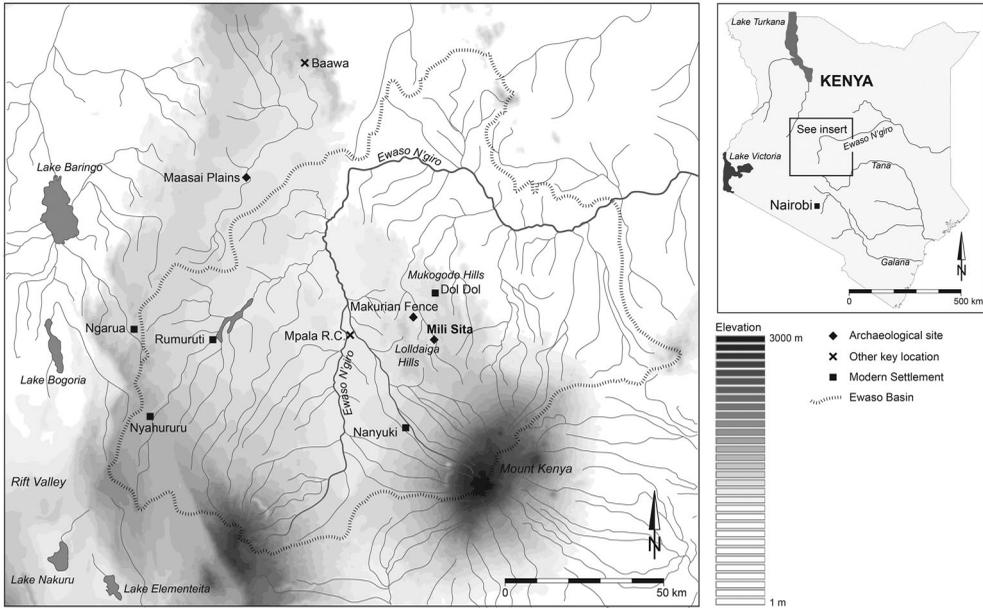
## Anthropogenic glades

At a global scale, savanna ecosystems can vary considerably with respect to tree and shrub coverage (Ratnam *et al.* 2011); in eastern Africa, these variations also occur at a local level such that these environments are mosaics of distinct ecological communities with variably diffuse or abrupt boundaries (Young *et al.* 1995). One driver of this heterogeneity is pastoralism, a fundamental feature of which is that livestock must be enclosed overnight for protection from predators and theft (Western and Dunne 1979). Among the Maasai, and other pastoral societies in eastern Africa, settlements are constructed first by clearing an area of vegetation, before erecting houses and fences around a central corral (Mbae 1990). Dung accumulates within this enclosure, enhancing nutrient content in local soils. This enrichment fosters distinctive sequences of vegetation succession, with rapid recolonisation of these glade sites by rich grasses that attract grazing animals, both wild and domestic (Young *et al.* 1995; Augustine 2003a; Veblen 2013); one of these groups of grasses, *Cynodon* spp., is known as ‘*manyatta* grass’ to the Maasai,<sup>3</sup> who recognise its association with former settlements and consider it a key forage species (Muchiru *et al.* 2009). Indeed, a general preference towards *Cynodon* spp. has been suggested for the wider grazing ungulate community (Pratt and Gwynne 1977). The presence of grazing animals within glades serves to discourage the regrowth of woody species, and their dung ensures the continued nutrient augmentation of the soil (Augustine 2003a; Muchiru *et al.* 2008, 2009).

In response to such processes of nutrient recycling, glades can endure for considerable periods of time. Studies from across eastern and southern Africa (e.g. Blackmore *et al.* 1990; Causey and Lane 2005; Muchiru *et al.* 2008) have proposed correlations between glades or other patterns of anomalous vegetation — such as patches of *Acacia*-dominated communities within *Burkea*-dominated environments in South Africa (Blackmore *et al.* 1990) — and concentrations of archaeological material, supposing that these features can endure for centuries or longer. This time depth has encouraged the integration of these features into the ecological functioning of the savanna, such that they have become a vital component; for instance, phosphorus concentrations in grasses in non-glade locations in central Laikipia have been shown to be below the levels required by pregnant and lactating impala (*Aepyceros melampus*), while these are exceeded within glades (Augustine 2004; Muchiru *et al.* 2009). The localised concentration of nutrients in abandoned pastoralist settlements can also have beneficial effects at other trophic levels. For instance, invertebrate populations, specifically flies and beetles, often show ‘significant positive correlations to [the] amount of dung deposited on abandoned settlements’ (Söderström and Reid 2010: 187). Higher populations of insects may also partly account for the higher densities and wider species diversity of birds near these locations (Morris *et al.* 2008).

## The study area

Maili Sita is located atop a low col across one of the northward-trending ridges that characterise the Lolldaiga Hills, a rare instance of raised topography in the southeast corner of the Laikipia Plateau, a 9000-km<sup>2</sup> area of high-altitude (some 1500–2200 m a.s.l.) savanna in central Kenya (Figure 1). The hills, which have a maximum elevation



**Figure 1.** Map of the Laikipia Plateau showing the location of Mili Sita and other sites mentioned in the text (adapted from Lane 2011:14).

of around 2250 m a.s.l., are an outcrop of the Precambrian African basement complex amidst the Miocene-age flood phonolite lavas that dominate the plateau. As well as their slightly anomalous geology, the Lollidaigas are ecologically distinct, falling into Zone III (agricultural highlands), according to the criteria established by Pratt and Gwynne (1977), while the remainder of the plateau is categorised as Zone IV (semi-arid with marginal agriculture). That is not to say that farming is practised in the hills today; the area is encompassed by the 200 km<sup>2</sup> area of Lollidaiga Hills Ranch, a privately owned livestock ranch and wildlife conservancy established under the European settlement drives of the 1920s (see Lemoosa 2005; Hughes 2006), which currently holds some 4000 head of cattle.

Previous investigations in Laikipia have pointed to the importance of the region in narratives of both the emergence of early modern humans as well as the spread and development of specialised pastoralism. Middle Stone Age (MSA) and Later Stone Age (LSA) levels have been recorded at Shulumai and Kakwa rock shelters in the Mukogodo Hills on the western edge of the plateau (Kuehn and Dickson 1999; Dickson *et al.* 2004) and excavations of three rock shelters at Kisima Farm suggested occupation by pastoralist communities during the Pastoral Neolithic (PN, c. 5000–1200 BP) through to the Pastoral Iron Age (PIA, c. 1200–200 BP; Siiriäinen 1984). However, little subsequent work had been done prior to a series of projects initiated by the British Institute in Eastern Africa (BIEA) between 2004 and 2010, which looked at patterns of land use and environmental change across the plateau (Lane 2005, 2011; Taylor *et al.* 2005; Muiruri 2008), with considerable attention paid towards the Lollidaiga Hills. Survey of the main valley (west of the Maili Sita col) recorded numerous sites on the basis of surface scatters of ceramics and obsidian artefacts (Causey 2005, 2008, 2010; Causey and Lane 2005; Lane 2005). Based

on the presence of Nderit, Maringishu and Narosura wares — the latter case being the first record from the Laikipia Plateau (Causey 2010)<sup>4</sup> — and formal similarities with sites like Ngamuriak, dated to 2135 ± 140 BP (GX8533, Robertshaw 1990), a number of these sites are attributed to the Pastoral Neolithic (PN), thus representing the first examples of open-air sites from that period to be recognised in Laikipia. Other locations yielded Kisima ware, first noted at the eponymous site in levels associated with the PIA and tentatively associated with the emergent Laikipiak Maasai (Siiriäinen 1984). The most intensive investigations, however, were directed towards Maili Sita and on Mugie Ranch to the northwest (see below).

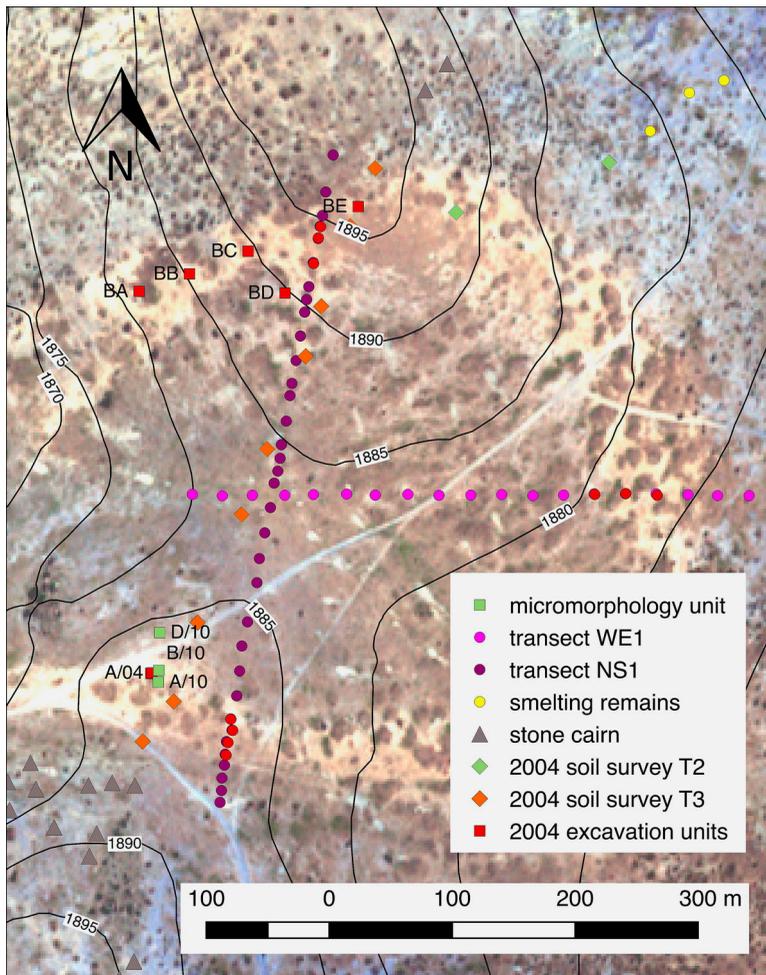
### Maili Sita: the story so far

The Maili Sita col, which is approximately 500 m wide, slopes gently to the east and west into the alluvial valleys of seasonally flowing rivers. In contrast to much of the surrounding plains and valleys, which are generally open scrub woodland thickening in the vicinity of river channels, it is covered by open grassland. The setting typifies the kind of settlement location preferred by contemporary Maasai and Samburu communities in Kenya (Spencer 1965, 1973; Western and Dunne 1979). The locality's diverse archaeological record includes residues of a significant iron smelting industry (Iles and Martín-Torres 2009; Iles and Lane 2015) and upwards of 55 stone cairns with human interment in at least one (Lane *et al.* 2007), clustered immediately to the northeast and south of the main site, respectively (though a third, less dense cairn complex follows the ridgeline to the north) (Figure 2). While dates for the smelting remains match well with those for the main site (post-1670 cal AD, Beta-212297; Table 2), in lieu of independent dating evidence for the single excavated cairn it remains unclear whether these structures are coeval. There is, however, a strong tradition of cairn construction among pastoralist groups in eastern Africa (Davies 2013) and other examples of cairns in association with PIA sites have been recorded in the region (Lane *et al.* 2007; Lane 2011; Straight *et al.* 2015).

The main site, which encompasses an area of 250,000 m<sup>2</sup> across the centre of the col, was excavated over several seasons between 2004 and 2010. Perhaps the most notable features of the site at surface level are patches of long grass, initially vaguely recorded as 'buffalo grass' (Lane 2005, 2011; Payton 2005), but recently confirmed as *Pennisetum stramineum*. These were taken to mark the sites of former livestock enclosures, called *bomas* in KiSwahili, following the ideas outlined in the previous section of soil nutrient enrichment and distinctive vegetation regrowth at such locations, many of which have been developed at the Mpala Research Station, 20 km west of Lolldaiga Hills Ranch (e.g. Young *et al.* 1995; Augustine 2003a, 2003b; Veblen 2012, 2013; Donihue *et al.* 2013).

The 2004 excavations recorded a linear arrangement of stake-holes towards the southern end of the site, alongside a hearth-like feature and in close association with one of the grass patches. These were thought possibly to represent the remains house of a typical Maasai-style house, comprising a dung-plastered, wattle frame (Lane 2005; see Andersen 1977). However, in contrast to the only previous record of a pastoralist domestic unit in eastern Africa, at the PN site of Ngamuriak (Robertshaw 1990), no trace of a floor platform was observed and it is possible that these features mark the fencing of a stock pen. One of the stake-holes yielded a radiocarbon date of 240 ± 40 BP (Beta-189981; Table 2),

which, alongside the preponderance of Kisima ware in the ceramic assemblage, is consistent with occupation during the notional period of Laikipiak expansion (Lane 2011), always assuming that Kisima ware was associated with the Laikipiak even if it was not necessarily made by them (Grillo 2012, 2014). Additional excavation units initially sought to establish the nature and spatial distribution of archaeological deposits, before subsequently focusing on areas identified during survey as being rich in archaeological material. The faunal assemblage was dominated by cattle and caprines, 60% of which were identifiable to taxon, an unusually high percentage that may indicate specific culinary or butchery practices (K. Mutundu, pers. comm. 2010).<sup>5</sup> Further excavation in 2010 across the southern (close to the 2004 unit A) and central portions of the site offered additional indication of intense activity to the south and east of the site, with dense midden deposits recorded at unit J, while dGPS survey recorded the locations of the grass patches and mapped distribution of ashy deposits visible at surface level. Figure 2 shows the distribution of the excavation units and survey data points.



**Figure 2.** Map of the Maili Sita site, showing key features and investigative units, overlying Worldview-2 satellite image.

Alongside the 2004 excavations, detailed study was made of the soils across the Maili Sita col (Payton 2005). One transect followed the line of the ridge top, while a second ran west to east from the top of the col at its northern end, to the foot of its eastern pediment slopes, with the aim of elucidating the catenary sequence. The survey revealed a pattern of poorly developed Chromic Luvisols, rarely more than 40 cm deep and lacking a well-developed A-horizon, which appears to have been stripped leaving deposits of quartz residuum. There is evidence that the soils across the ridge and its flanks were subject to considerable erosion in the past; indeed, there are substantial erosion gullies along the ridge flanks to the south of the site, in places over six metres deep, yet of a morphology that suggests relatively recent occurrence. Payton (2005: 51) has speculated that this gullying may have been triggered by the daily movement on livestock in and out of the settlement, creating trackways that facilitated and concentrated run-off; a parallel can be seen across Lolldaiga Hills Ranch today, where graded road surfaces become heavily rutted after periods of rain. In contrast, test pitting along the ridge top has demonstrated enrichment of soils in some areas of the site, in the form of high organic carbon, exchangeable calcium and exchangeable potassium, with evidence of severe sheet erosion elsewhere. Furthermore, particular enrichment of soils underlying the *P. stramineum* patches (Payton 2005: 54–55) could support their designation as former *boma* sites and intimate that erosion occurred prior to or concurrent with the principal occupation. Thus, while pastoralist activity may have incurred a cost on the surrounding landscape, in the form of the intense gullying, this is balanced by a pattern of nutrient concentration atop the Maili Sita col.

### Recent approaches

Recent research has sought to develop the findings of these earlier investigations at Maili Sita, with the principal aim of better integrating the archaeological and ecological records so as to comment on the enduring ecological effects of pastoralist settlement in a semi-arid savanna environment. The research reported here thus offers an archaeological deep-time perspective on the kinds of research questions being pursued by ecologists working at the Mpala Research Centre (references above), as well as improving our understanding of the development of contemporary pastoralism in an important yet poorly understood location, the Laikipia Plateau. Besides the aforementioned work on glade formation, this research has also been inspired by the geo-ethnoarchaeological investigations undertaken by Ruth Shahack-Gross and colleagues (Shahack-Gross *et al.* 2003, 2004, 2008; Shahack-Gross 2011), which have considered recently abandoned Kisongo Maasai villages in Kajiado District, southern Kenya, using oral records of spatial arrangement to reveal the geoarchaeological signatures one might expect in particular activity areas. Building on existing work on faecal spherulites (Canti 1997, 1999) and micro-laminations in the soil structure caused by trampling (Courty *et al.* 1991; Macphail *et al.* 1997) as records of degraded dung deposits, Shahack-Gross *et al.* (2003, 2004) attempted to define a taphonomic sequence for livestock enclosure sediments in eastern Africa and to explore whether other activity areas might be similarly identifiable using geoarchaeological techniques such as soil micromorphology, mineralogy, phytoliths and stable isotope analysis. The current work at Maili Sita seeks to bridge these diverse perspectives; where the primary concern of Shahack-Gross and colleagues was with the archaeological record — albeit using soil data that could be construed as an ecological resource — and glade

ecologists have looked specifically at the impacts of livestock presence with only limited consideration of the historicity and dynamics — i.e. the human element — of that presence, the work at Maili Sita assumes the position of Historical Ecology: that the two are inextricably intertwined (e.g. Crumley 1994; Balée 1998; Lane 2016b).

### Field strategy

Several data sources have been pursued in recent work at Maili Sita, the bulk of which relates to the composition of the deposits across the col; this follows the work by Payton (2005) described earlier, though focusing on different and complementary variables, with greater attention given to the association of the soil data with more directly archaeological information. Recent work has also employed a more intensive sampling strategy in order to achieve the resolution needed to access the kinds of potential data advocated by Shahack-Gross *et al.* (2003, 2004).

In March 2015, bulk soil samples were obtained using a bucket auger, at depths of 0–5 cm, 5–15 cm and 15–30 cm along two transects, one (NS1) following a similar north-south path along the ridge top to that used by Payton (2005), with a second (WE1) running east to west across the apparent centre of the site down slope into the *Acacia* thicket that borders the site on all sides. Samples were taken every 25 m along the 475 m east-west transect, and between 10 and 30 m north-south for 530 m. A third survey transect (EWp1) followed a 24 m path between two of the grass patches close to excavation unit A, with samples taken every 2 m at a depth of 5–15 cm. Regional control data were derived firstly from samples at the respective limits of the transects NS1 and WE1, beyond the limits of the archaeological site (based on ground survey and satellite imagery, see below) and the extent of the Maili Sita ‘glade’. For some analyses, these are augmented by data from the wider area obtained during the 2004 soil survey (Payton 2005; unpublished data). Column samples for soil micromorphology were taken from a number of the 2010 excavation units (during the excavation), and stored at the British Institute in Eastern Africa (BIEA) in Nairobi. All bulk samples and three column samples — those corresponding to units A, B and D, chosen to cover a variety of the contexts recorded under excavation — were exported to the United Kingdom for analysis at the Institute of Archaeology, University College London (UCL).

In addition, a return visit to the site in January 2016, shortly following the rainy season, such that vegetation was near peak levels, allowed detailed survey of species representation across it. This was conducted along the two soil survey transects. Having relocated the original sample locations using a handheld GPS device, the species present within a 0.5 m radius of the sample hole were recorded, along with an approximation of their density. When unknown, detailed photographic records were made to allow later identification using reference texts (Weiss 1989; Dharani 2002; Agnew 2013). Where multiple distinct vegetation communities were present within a sample locale, only that which incorporated the precise location of the soil sample was considered, with a note made of its proximity to varying conditions.

### Laboratory methods

Prior to thin section manufacture, sub-samples weighing approximately 100 g of sediment were taken at 5 cm intervals along the column samples with the goal of subjecting them to

the same set of analyses as those from the transects. Thin sections were manufactured according to the conventional procedures defined by Courty *et al.* (1989); impregnation with epoxy resin (3:2 resin to acetone, with MEKP catalyser) was conducted at UCL and blocks sent to Spectrum Petrographics for slide manufacture (50×75 mm slides). Observations were made using a Leica DM EP optical microscope at 2.5x to 50x magnification and recorded using the procedures and terminology defined by Bullock *et al.* (1986) and Stoops (2003).

Bulk samples were tested for total carbon (Ct) and calcium carbonate (CaCO<sub>3</sub>) content using the loss-on-ignition method (muffle furnace at 550°C for two hours, and 1000°C for one hour, respectively). Magnetic susceptibility readings were taken on 10 cm<sup>3</sup> of sample using a Bartington MS2 low-frequency sensor and pH is given based on the average of three readings of a 1:2 sample to de-ionised water solution taken using an Hanna HI-9024 instrument, calibrated using pH 4, pH 7 and pH 10 buffers. All the samples were sieved to <2 mm prior to analysis. Preliminary quantitative analysis of faecal spherulites of the unit A samples was undertaken by J. Cogdale, following the protocol outlined by Canti (1997).

## Results

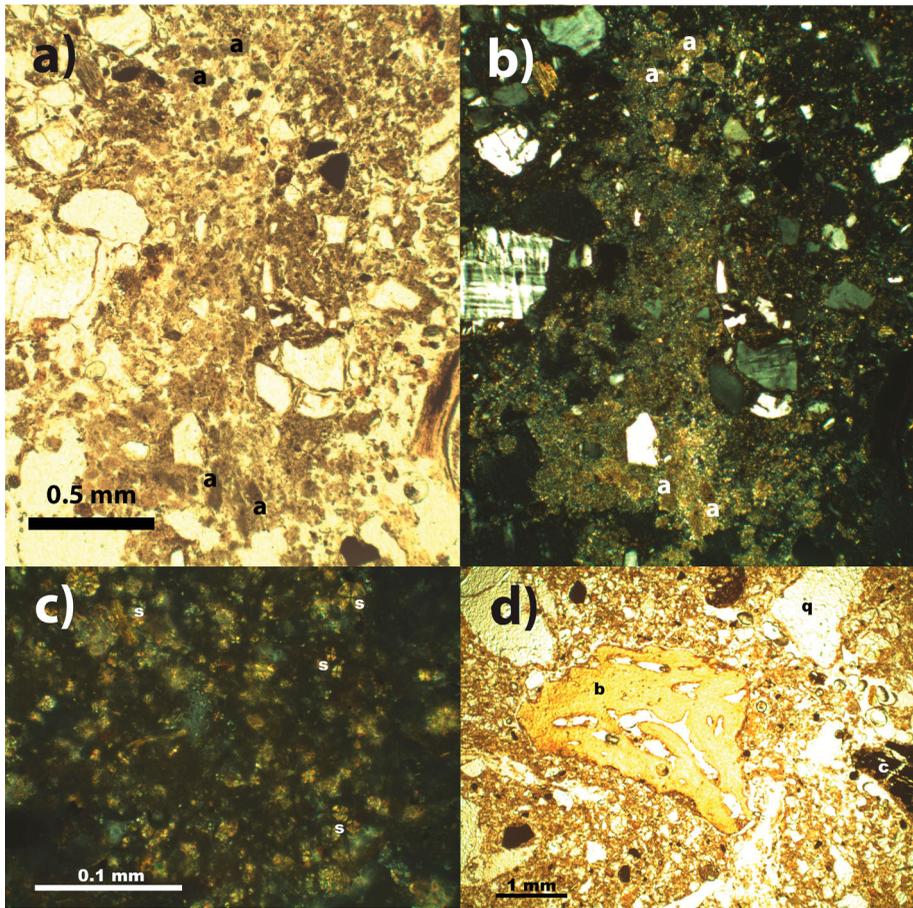
### Micromorphology

Table 1 summarises the observations made of the thin sections from 2010 excavation units A, B and D, which generated four, three and three thin sections, respectively. A general fabric of granular excremental pellets across the three sample locations indicates a high level of bioturbation by soil fauna. Termites (*Macrotermes* spp.) are present in great numbers across the lower northern end of the Lolldaiga Hills Ranch and their capacity for turnover of sediments in eastern Africa, in a manner that could be expected to result in this kind of fabric, is well documented on Lolldaiga (Qandelihle 2010) and elsewhere on Laikipia (Jungerius *et al.* 1999), as are their more general taphonomic contributions to African archaeological site formation (McBrearty 1990) and savanna ecodynamics (Jungerius *et al.* 1999). While a detailed discussion of the ecological role of termites is not possible or appropriate here, it is worth noting the similarity of soil composition and nutrient dynamics within and around termite mounds and that noted for livestock enclosures; for instance, both have been noted to exhibit elevated pH, calcium and magnesium levels (e.g. Augustine 2003; Muchiru *et al.* 2009; Okullo and Moe 2011; Joseph *et al.* 2013). That termites may be preferentially attracted to the large quantities of deadwood left at abandoned pastoralist settlements is also well attested. Hence, their potential to further enhance soil nutrient levels at and around such sites needs to be acknowledged. We would argue, however, that the features exhibited at Maili Sita show sufficient evidence of anthropogenesis to discount the demonstrable ‘ecosystem engineering’ capabilities of termites (after Dangerfield *et al.* 1998) as the primary drivers of landscape transformation.

Broadly, the samples from unit A are the only ones to give any strong indication of anthropogenic input; in the upper (anthropogenic) levels, unsorted mineral grains (probably basalt-derived) are randomly distributed within a clay-poor, granular groundmass showing no ped development. Also present are occasional fragments of charcoal and

**Table 1.** Maili Sita: summary of soil micromorphological observations.

Unit	Microstructure	Fine fraction	Coarse fraction and inclusions	Notes (anthropogenic inclusions and pedofeatures)	Interpretation
<b>A</b> 0–300 mm Four slides	Complex massive/granular (total excremental fabric; evidence of severe bioturbation throughout, but slightly more so in the higher levels; 30–50% complex packing voids (more compacted at lower levels); some channels and vughs. Weakly developed.	High order speckling of b-fabric throughout; increasing clay content with depth.	More coarse material at surface (70:30 c:f, 50:50 at the base); 95% unsorted, sub-angular quartz; coarse silt to small pebble single grains; rare iron and/or clay rich nodules; well-accommodated with sharp boundaries; high magnetite content.	Charcoal flecking throughout, approximately 2% total area, decreasing with depth, some coarse sand-sized charcoal inclusions; several sand-sized fragments of bone, with no staining of surrounding matrix; frequent accumulations of faecal spherulites, particularly in the upper levels; clay coatings of coarse grains increase with depth (rare in the uppermost deposits); some infilling of voids with excremental pellets; pockets of rhomboidal calcium carbonate crystals, likely ash.	Rich in dung and ash, as evidenced by the spherulites, high charcoal content and calcium carbonate features. Also marked by a high pH, CaCO <sub>3</sub> and organic C content, slightly elevated magnetic susceptibility and high finds density in excavation suggesting general refuse deposits commensurate with livestock enclosure (e.g. Mbae 1990; Shahack-Gross 2003).
<b>B</b> 0–190 mm Three slides	Two distinct fabrics in the uppermost slide; frequent horizontal striations/microfacies that are organic rich only in the top 25 mm; remaining fabric is complex massive/excremental, similar to A; approximately 30% complex packing voids, 10% channels with undulating, rough walls. Weakly developed.	Dark to greyish brown (diffuse changes) in XPL with occasional light speckling; main fabric slightly darker than the top 25 mm; otherwise undifferentiated.	Generally 30:70 c:f except in the deepest sediments (60:40, though large pebbles add to the coarse ratio); 80–90% unsorted quartz (10–20% feldspar and mica); sub-angular, fine sand to coarse sand single grains; rare clay or iron-rich nodules, similar mineral content to main fabric; more rare with depth.	Some charcoal flecking; less than in A; more common in top striated fabric (approximately 2%) than lower down (<1%); spherulites present throughout but more frequent with depth; less frequent than in A; loose infilling of channels with excremental pellets; some micritic calcite on void walls; some micropan clay coating of coarse grains, more frequent with depth.	Slightly elevated pH and magnetic susceptibility, some spherulites and calcium carbonate features suggest this marks the edge of the dense midden deposits in unit A, still showing some input of dung and ash residues. A medium finds density in excavation suggests proximity to domestic or refuse areas.
<b>D</b> 0–190 mm Three slides	Homogeneous; complex, massive granular/excremental pellets (more massive with depth); 10% complex packing voids; 20% channels, some infilled with pellets.	Dark brown in XPL; light to very light speckling throughout, but less so with increasing depth.	50:50 c:f throughout; 80–90% quartz, sub-angular, unsorted single grains (10% feldspar and mica); fine to coarse sand, large grains more spherical; a single iron-rich nodule in the middle sediments; very clear boundaries; mineral content as main fabric.	Very rare charcoal flecking (possibly magnetite — fine silt grains) only in surface deposits; significant organic staining of fine fraction (dark brown in PPL), more in the top sediments; rare phytolith accumulations in voids; common infilling with pellets, very rare micropan clay coating of coarse grains, less common with depth.	pH is consistent with regional control levels (i.e. 6.5–7.0) and no reliable indication of anthropogenic inputs. Low-medium finds density in excavation suggests this is part of the site, but not an enclosure, midden or intensive activity area.



**Figure 3.** Maili Sita: photomicrographs of micromorphological features in unit A/10 thin sections: a) rhomboidal calcium carbonate ash crystals (a), x50, PPL; b) x50, XPL; c) faecal spherulites (s), x500, XPL; d) bone (b); and charcoal (c), x25, PPL.

bone alongside rhomboidal calcium carbonate ash crystals (cf. Canti 2003; Braadbaart *et al.* 2012; Figure 3a-3b), carbonate accumulations in voids, frequent charcoal flecking commensurate with the kinds of refuse deposits expected at herder settlements (Brochier *et al.* 1992; Macphail *et al.* 1997; Shahack-Gross *et al.* 2003). The samples contained relatively dense accumulations (>30) of faecal spherulites — carbonate minerals formed in the gut of grazing animals (Canti 1997; 1999; Figure 3c) — and a crystallitic (XPL) b-fabric, indicative of degraded dung deposits. Spherulites were most concentrated in the upper-middle deposits (10–15 cm), below which there was a sharp rise in the relative proportion of the smallest spherulites, perhaps due to percolation down the soil profile, and a sharp drop in overall quantity (Cogdale 2015). The upper deposits of unit A also showed elevated  $\text{CaCO}_3$  levels (up to 4.5%), comparable with the mean (4.9%) for the peaks in the transect data (see below). Both  $\text{CaCO}_3$  and spherulite density decrease with depth in the lower half of the profile. These lower, archaeologically sterile levels show greater clay content and a non-crystallitic b-fabric with very little charcoal, although they remain comprised of the excremental pellet structure of the upper deposits, indicative of

intense bioturbation throughout the profile. Unit B shows some spherulites and charcoal flecking, but at much lower densities than unit A, and lacks clear evidence for ash. This profile also registers a lower pH (7–7.5) than unit A (pH 8–8.5), though this is still above that of off-site levels (pH 6–7). Unit D, contrastingly, registered a pH consistent with these regional controls. Nor were any spherulites observed in unit D, where rare, black, silt-sized flecking (PPL) could not be reliably distinguished as either charcoal or magnetite. It should be noted that across the samples spherulite concentration did not appear to be strongly associated with pH, an indication that presence in certain deposits cannot be explained simply by heightened alkalinity caused by ash inputs, for example (Canti 1997; Demeyer *et al.* 2001).

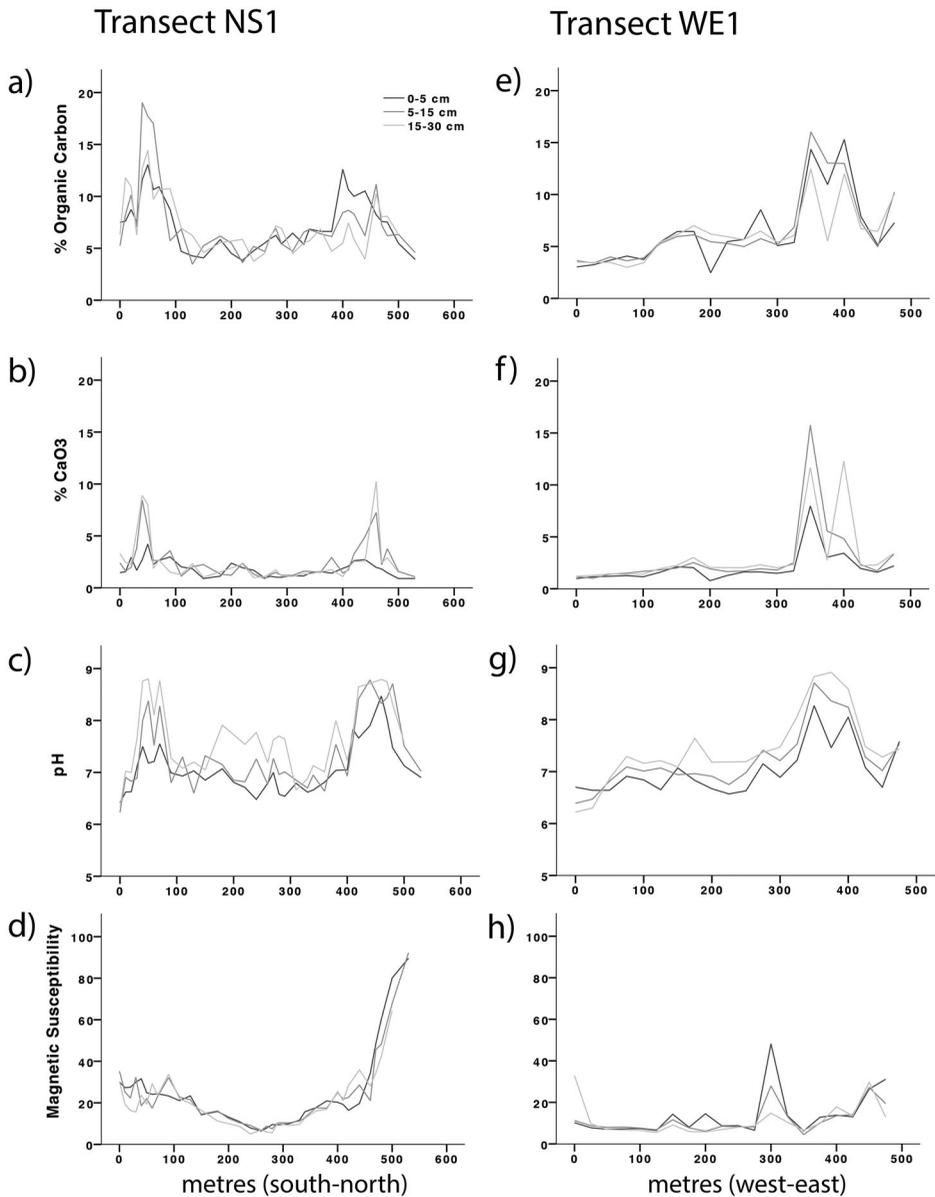
### Transect surveys

Figure 4a-d shows variation in % organic carbon, % calcium carbonate ( $\text{CaCO}_3$ ), pH and magnetic susceptibility (low frequency, expressed in tesla SI units), respectively, across transect NS1, while Figure 4e-f shows the same across transect WE1. The first three variables are visibly and statistically correlated (0.01 level, Pearson's  $r$ ), showing clear peaks deviating towards the northern and southern ends of NS1 — locations pertaining to the same areas of the col that showed unusual enrichment in Payton's 2004 survey — and the eastern end of WE1. Of the samples from the central part of the col, only soil pH shows any significant deviation from off-site levels. Although magnetic susceptibility across NS1 and WE1 is elevated at the northern and eastern ends, this continues beyond the perimeter of the site and shows no correlation with the other variables. Of some interest though is the extreme peak at 300 m along WE1, which is most pronounced in the surface deposits. That this anomaly is only registered in the magnetic susceptibility reading, however, supposes that its origin might be an intense localised raising of soil temperature as might be caused by a lightning strike (cf. Maki 2005).

Transect EWp1 showed no clear variation in the deposits between the grass patches, a finding at odds with the pattern described by Payton (2005), although the data for all variables is comparable with that observed for the southern peak of NS1. Vegetation growth, however, is significantly different; the patches themselves are comprised predominantly of *Pennisetum stramineum*, with *Cynodon dactylon*, *Kyllinga* sp. and *Panicum* sp., and occasional *Solanum incanum* and *Achyranthes aspera* ('Devil's horsewhip'). Beyond the patches, areas in the vicinity of the northern, southern, and western peaks (NS1, WE1 and the non-patch samples of EWp1) are fairly bare of vegetation, with the occasional presence of *C. dactylon*.<sup>6</sup> The central expanse of the col, however, is dominated by *C. dactylon*, though beyond the limits of the site this changes to a mosaic of *C. plechtostachyus*, *P. stramineum* and *Themeda triandra*, with a concomitant increase in woody vegetation, almost exclusively *Acacia drepanolobium* ('Whistling thorn'). Dense and lush clumps of *C. plechtostachyus* and *P. stramineum* are frequent within the immediate vicinity of these *Acacia*.

### Discussion

Building on the corpus of earlier data relating to the occupation of Maili Sita, the current study shows that there is significant variation in sediment composition across the site.



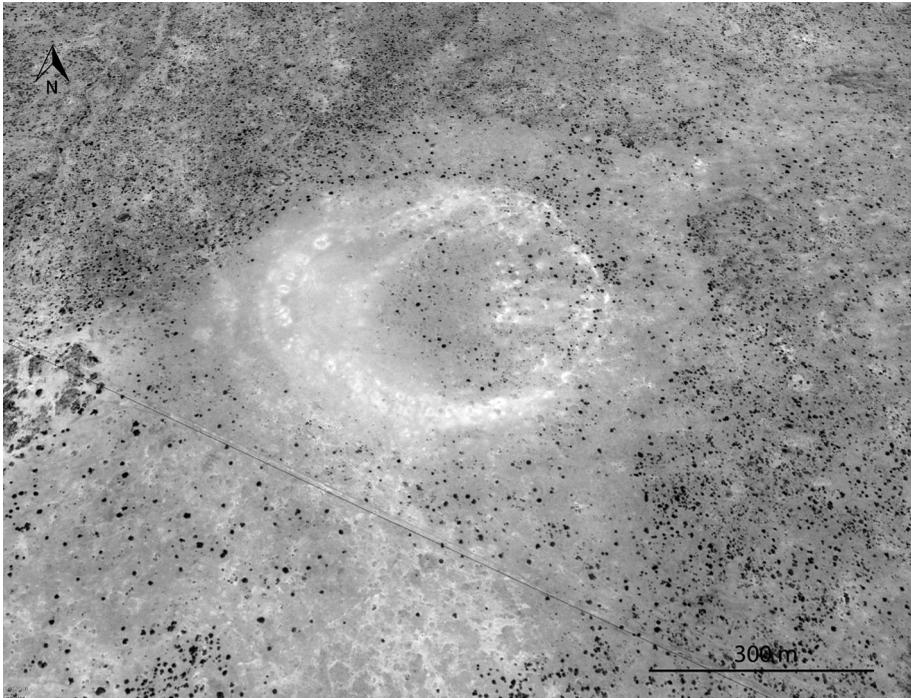
**Figure 4.** Maili Sita: organic carbon, calcium carbonate, soil pH and magnetic susceptibility across transects NS1 (a-d) and WE1 (e-h).

Concentrations of faecal spherulites, organic carbon, calcite and phosphorus towards the perimeter of the col, as indicated by the transect surveys, are consistent with degradation of the kinds of dung and ash deposits observed at contemporary pastoralist settlements (Western and Dunne 1979; Mbae 1990; Shahack-Gross *et al.* 2003, 2004, 2008) and vegetation patterning echoes that noted at *boma*-related savanna glades in modern ecological studies, with an exclusion of woody species in favour of rich grasses (e.g. Muchiru *et al.* 2009; Veblen 2012; Veblen 2013). It should be noted that the species represented at

Maili Sita and their relative distributions do not exactly match the patterns noted at experimental *bomas* at nearby Mpala Research Centre. For instance, at Mpala, *Cynodon plechtostachyus* — ‘manyatta grass’ — is observed to dominate species composition after 5–20 years, with *Pennisetum stramineum* restricted to glade edges, while at Maili Sita it is *Cynodon dactylon* that dominates — as it does at Makurian Ranch (see below) — while *P. stramineum* is present in patches across the site. It is difficult to draw firm conclusions as to the root causes and implications of such distinctions, which are likely to be driven by subtle variations in ecosystem dynamics between the two locations. Moving further afield, former herder settlements in South Africa, for example, are marked by circular groves of *Acacia tortilis*, yet show a comparable soil nutrient composition to that at Maili Sita and Mpala (Blackmore *et al.* 1990). Such differences within the broader pattern of glade formation do, however, highlight the need for regionally diverse studies if this kind of ecological information is to be useful from an archaeological perspective.

Our study has thus far not recognised any of the more subtle variations that might be used to reconstruct specific elements within a settlement as explored by Shahack-Gross (2003, 2004). Yet, if the results of the recent soil and vegetation surveys are considered with respect to high-resolution satellite imagery, a broader pattern becomes apparent. The site plan in Figure 2, which shows the sample locations along transects NS1 and WE1, overlies a Worldview-2 image, acquired in May 2011. Perhaps the most immediately visible feature is the continuous pale ring which encircles the col and, as shown by ground-truthing in support of Soil Adjusted Vegetation Index (Huete 1988; Zhang *et al.* 2009) conducted on the satellite imagery, is largely composed of bare soils interspersed with patches of *P. stramineum*. The data peaks in the variables outlined above fall exclusively within this area, presupposing that the entire ring is comprised of those same dung and ash deposits. Crucially, this implies that no significant alteration of the soil ecology occurred within the ring and that, given the continuous and homogenous nature of these ring deposits, activity was concentrated around the entire perimeter of the site in a single, or series of single, sustained episodes of occupation. That the 2010 excavation units D-I located within the ring yielded very little in the way of either artefacts or faunal remains, while the 2004 trenches BA-BE located to the north and at the ring edge on the upper slopes of the col had richer assemblages, lends some support to this view. Even more intriguingly, the scale of such an occupation would exceed that of almost anything previously recorded for pastoralist settlements either archaeologically or ethnographically in eastern Africa, while the layout contrasts with any site-type associated with the Maasai (cf. Mbae 1990) or their immediate neighbours, the Samburu (cf. Spencer 1973).

However, a scan of Google Earth™ imagery across the Laikipia Plateau and its immediate surroundings — the Leroghi Plateau and Samburu to the north and east, and Lake Baringo and the Rift Valley to the west — presents numerous other locations exhibiting similar characteristics. One of these, Makurian Ranch (37 N 290344.18, E 37639.59), located immediately north of the Lolldaiga Hills Ranch within land belonging to the local community group ranch, was visited briefly during recent fieldwork at Maili Sita. It is clear from the satellite image (Figure 5) that there are visible similarities with Maili Sita — the site is of a similar size, 400–500 m in diameter, showing pale deposits in a roughly circular ring within a treeless glade dominated by *C. dactylon* — and scattered across the surface of the site, but particularly concentrated around the perimeter, are obsidian flakes and Kisima ceramics suggestive of a mid-to-late second millennium AD



**Figure 5.** Makurian Fence site, Google Earth™ image taken on 6/3/2015. The black line to the south of the site marks the boundary of the Lolldaiga Hills Ranch.

occupation. A second example, Maasai Plains (37°N 234817.95, E 80456.77), which was investigated under the same project as the original excavations at Maili Sita (Lane 2005, 2011), exhibits concentric rings of organic-rich, ashy deposits between 400 m and 700 m in diameter and has been dated to  $480 \pm 50$  BP (1315–1623 cal. AD, Beta-189982; Table 2).

The disparities shown between Maili Sita and sites like Makurian Ranch and Maasai Plains and ethnographic records of pastoralist settlement in eastern Africa indicate a social landscape distinct from that which developed and was observed on the Laikipia Plateau during the colonial period and throughout the twentieth century. The upheavals of the late eighteenth and nineteenth centuries, when catastrophic regional drought (Bessems *et al.* 2008), the Iloikop wars (Waller 1979), rinderpest epidemics (Mack 1970) and the *Pax Britannica* (Hughes 2006) all contributed to the replacement of the Laikipiak with Purko Maasai, belie an earlier cordiality, in which Iloikop communities such as the Momonyot, Il-Chamus and Samburu, as well as the Laikipiak and hunter-gatherer groups like the Mukogodo, coexisted and engaged in extensive exchange networks (Waller 1979). It is now widely accepted that these contemporary ‘ethnic’ distinctions arose from the tailoring of economic practices to the diverse environments these groups inhabit (Galaty 1993; Spear 1993a, 1993b).

This interactive sphere seems to have reached at least as far north as Lake Turkana (Lamphear 1993; Sobania 1993) and it is therefore unsurprising that the form of Maili Sita and other sites in Laikipia should present closer similarities with the modern settlements of Cushitic-speaking Rendille camel herders (Spencer 1973) than with those of

**Table 2.** Summary of radiocarbon dates for Mili Sita and Maasai Plains. Both the IntCal13 (Northern Hemisphere; Reimer *et al.* 2013) and SHCal13 (Southern Hemisphere; McCormac *et al.* 2004) calibrations are given, due to Kenya's position on the Thermal Equator, between the north-south oscillations of the Inter-Tropical Convergence Zone.

Site, unit, context and reference	Association	Material	Laboratory number	Date BP	$\delta^{13}\text{C}$ ‰	Calibrated date cal. AD (95% confidence interval using OxCal 4.2.4)	
						IntCal13 (Reimer <i>et al.</i> 2013)	SHCal13 (Hogg <i>et al.</i> 2013)
MS, Unit A, Context 007, January 2004 Lane (2011)	Charcoal from a stake hole, Unit A; Kisima ware; fauna	Charcoal	Beta-189981	240 ± 40	-22.6	1520–1593 (14.8%) 1619–1685 (40.0%) 1732–1808 (31.2%)	1628–1712 (32.2%) 1719–1813 (56.6%) 1836–1849 (1.3%) 1854–1883 (2.8%) Post-1925 (2.5%)
MS, CB, Context 412 20–26 cm charcoal rich fill of furnace, July 2004 Lane (2011); Iles and Lane (2015)	From the lower part of the basal fill of iron smelting furnace CB	Charcoal	Beta-212297	130 ± 40	-23.0	1670–1780 (39.8%) 1798–1896 (40.1%)	1677–1734 (21.2%) Post-1800 (74.2%)
MP, Unit A, Context 235 Lane (2011)	From the lower levels of a low, stratified ash and dung mound; Kisima ware; stone artefacts; fauna	Charcoal	Beta-189982	480 ± 50	-25.2	1315–1356 (8.3%) 1388–1499 (84.9%) 1506–1511 (0.4%) 1601–1616 (1.8%)	1400–1512 (82.1%) 1549–1559 (1.0%) 1573–1623 (12.4%)

the Maasai or Samburu (Mbae 1990; Spencer 2003). Indeed, unverified oral histories have indicated an influx of pastoralist Oromo-Cushitic speakers — the Warra Daaya (sometimes *Wardei Daaya*) — into Laikipia from the eastern Lake Turkana region during the mid-sixteenth century (Tablino 1999; Lemoosa 2005), events and interactions that may account for the Cushitic-based Yaaku language spoken by Mukogodo hunter-gatherers prior to their twentieth-century adoption of Maa (Cronk 1989). Although most scholars believe the Laikipiak to have been Eastern Nilotic speakers (e.g. Waller 1979; Sobania 1993), the evidence presented here revives Jacobs' (1965: 66) notion of an Eastern Cushitic origin. Spencer (1973: 20) offers the interesting reasoning for the large size of Rendille villages that the strength of consensus opinion made possible by large gatherings aids community cohesion in an essentially heterarchical society, proposing that any economic arguments are 'rationalisations of this essentially social choice'. Following this argument, it may be that the founding of large settlements contributed to the ability of pre-nineteenth-century populations to engage in economically and culturally symbiotic inter-relationships within a diverse ethnic mosaic. Equally, McCabe (2004: 53–54) has documented how the Turkana temporarily congregate in large settlements or clusters thereof, known as *adakars*, in response to inter-ethnic conflict. Were Maili Sita the result of a similar phenomenon, the opportunity to strengthen communal bonds and reinforcement of shared identities amid stressful external pressures may have had a comparable effect, with possible, but as yet unexplored, ramifications for the use of material culture style to create and signal different dimensions of personal and group identity (although see Larick 1986a, 1986b, 1991). Pertinent here also is Anderson's (2016) recent argument that owing to the linked social and ecological catastrophes that affected the Lake Baringo region in the nineteenth century there was significant depopulation of the area and, after these challenges had eased, a re-'assembling' of social practice so radical that the cultural reckoning of time began again. These nineteenth-century disasters certainly would have extended eastwards across the Laikipia and Leroghi Plateaux where cultural memories of their impacts remain strong (Waller 1988; Straight *et al.* 2016), as well as further north toward Lake Turkana (Sobania 1988). A possible implication, still to be attested archaeologically, is that the abandonment of large sites such as those at Maili Sita may have triggered new forms of mobility and entailed changes in social and material practice of the same kind of order now being suggested for Baringo.

## Summary

Maili Sita appears to be emblematic of a distinctive social phenomenon that spanned the Laikipia Plateau during the latter half of the second millennium AD, prior to the disruptive wars and epidemics — along with the arrival of British colonial rule — of the nineteenth century. Northern Kenya is known to have played host to population movement on a considerable scale during this period, fostering interactions between diverse economic, cultural and linguistic groups out of which emerged the Rendille, Gabbra and Boran, among others (Spencer 1973; Schlee 1985; Kassam 2006). The convergence of these northern Cushites with the Maa-speaking pastoralist communities consolidated in the Rift Valley was surely one of the key drivers behind these ethnic definitions and the results from Maili Sita may go some way to positioning Laikipia at the centre of that interaction. What is more certain is that in order to recognise and understand population dynamics

during this period, or indeed earlier, we must reconsider the reliance of pastoralist archaeologies on fairly rigid settlement typologies as defined by a few key ethnographic works (e.g. Weston and Dunne 1979; Mbae 1990). As a modest step toward such an objective, we hope that this paper helps demonstrate the potential of using soil and vegetation data to investigate ephemeral sites associated with mobile communities without immediate recourse to such narrow analogies. In addition, the ecological studies highlighted here (e.g. Stelfox 1986; Augustine 2003b; Muchiru *et al.* 2008; Donihue *et al.* 2013; Veblen 2013) have focused on the effects of modern *bomas* on the savanna landscapes. The scale of the occupations at Maili Sita and Maasai Plains, and the potential duration of the ‘super-sites’ as a phenomenon — from at least the fifteenth until perhaps the nineteenth century AD — encourage further reconsideration of the long-term impacts of a pastoralist presence in eastern Africa’s arid and semiarid landscapes.

## Notes

1. The name ‘Maili Sita’ translates to ‘Mile Six’ from the KiSwahili, and refers to the position of the site along the northward-trending ridge. Earlier publications (e.g. Causey 2010; Lane 2011, 2013) referred to the site as ‘Mili Sita’, which translates, rather unfortunately, as ‘six corpses’. This error was only recently pointed out and we should like to take the opportunity to correct it here.
2. The site lies just north of the Equator, and, as detailed in Table 2, there are some minor discrepancies between the limited radiocarbon dates available when using both the northern hemisphere and southern hemisphere calibration curves.
3. A *manyatta* is a type of Maasai settlement, associated with age-set graduation ceremonies; the name is frequently erroneously applied to the principal Maasai homestead, called *enkang*.
4. Prior to this work, the known distribution of Narosura ware was limited to the west of the Rift Valley (Wandibba 1980) and as far south as Narok in the southern highlands of Kenya (Odner 1972), Nasera rockshelter in the Serengeti, around Lake Eyasi (Tanzania) at Mumba and other rockshelters (Mehlman 1989) and possibly on sites to the west of Kilimanjaro (Mturi 1986). More recent survey work has demonstrated its common presence also on open sites further south in Tanzania in the Mang’ola Basin (Prendergast *et al.* 2014) and along the southern edge of the Mbulu Plateau (Prendergast *et al.* 2013).
5. The bulk of the analyses of the faunal, botanical and artefactual remains from the different seasons of excavation at the site are ongoing. Among other trends, provisional interpretations of fungal spore data recovered from test-pit profiles at the southern end of the site further supports the orientation of the subsistence economy towards livestock (V. Muiruri, pers. comm., 2008), although more comprehensive analyses are needed to confirm this.
6. Turner (1976) provides an excellent illustration of this kind of patchy distribution of different grass species, bare earth and termite mounds found around recently abandoned cattle enclosures on a commercial ranch in a zone of *Combretum* savanna woodland in Bunyoro, Uganda (image reproduced as Fig. 2.21 in Lind and Morrison 1974: 100).

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### References

- Agnew, A. 2013, *Upland Kenya Wild Flowers and Ferns: A Flora of the Flowers, Ferns, Grasses and Sedges of Highland Kenya*. Nairobi: Nature Kenya.
- Andersen, K.B. 1977, *African Traditional Architecture: A Study of the Housing and Settlement Patterns of Rural Kenya*. London: Oxford University Press.
- Anderson, D.M. 2016 "The beginning of time? Evidence for catastrophic drought in Baringo in the early nineteenth century." *Journal of Eastern African Studies* 10: 45–66.
- Augustine, D.J. 2003a. "Long-term, livestock-mediated redistribution of nitrogen and phosphorus in an East African savanna." *Journal of Applied Ecology* 49: 137–149.
- Augustine, D.J. 2003b. "Spatial heterogeneity in the herbaceous layer of a semi-arid savanna ecosystem." *Plant Ecology* 167: 319–132.
- Augustine, D.J. 2004. "Influence of cattle management on habitat selection by impala on central Kenyan rangeland." *Journal of Wildlife Management* 68: 916–923.
- Balée, W. 1998. "Historical ecology: premises and postulates." In *Advances in Historical Ecology*, edited by W. Balée, 13–29. New York: Columbia University Press.
- Banning, E.B. and Köhler-Rollefson, I. 1992. "Ethnographic lessons for the pastoral past: camp locations and material remains near Beidha, southern Jordan." In *Pastoralism in the Levant: Archaeological Materials in Anthropological Perspectives*, edited by O. Bar-Yosef and A. Khazanov, 181–204. Chicago: Prehistory Press.
- Bessemis, I., Verschuren, D., Russell, J.M., Hus, J., Mees, F. and Cumming, B.F. 2008. "Palaeolimnological evidence for widespread late 18<sup>th</sup> century drought across equatorial East Africa." *Palaeogeography, Palaeoclimatology, Palaeoecology* 259: 107–120.

- Blackmore, A.C, Mentis, M.T. and Scholes R.J. 1990. "The origin and extent of nutrient-enriched patches within a nutrient-poor savanna in South Africa." *Journal of Biogeography* 17: 463–470.
- Braadbaart, F., Poole, I., Huisman, H.D.J. and van Os, B. 2012. "Fuel, fire and heat: an experimental approach to highlight the potential of studying ash and char remains from archaeological contexts." *Journal of Archaeological Science* 39: 836–847.
- Brochier, J.E, Villa, P., Giacomarra, M. and Tagliacozzo, A. 1992. "Shepherds and sediments: geo-ethnoarchaeology of pastoral sites." *Journal of Anthropological Archaeology* 11: 47–102.
- Bullock, P., Fedoroff, N., Jongerius, A., Stoops, G. and Tursina, T. 1985. *Handbook for Soil Thin Section Description*. Wolverhampton: Waine Research Publications.
- Canti, M.G. 1997. "An investigation of microscopic calcareous spherulites from herbivore dungs." *Journal of Archaeological Science* 24: 219–231.
- Canti, M.G. 1999. "The production and preservation of faecal spherulites: animals, environment and taphonomy." *Journal of Archaeological Science* 26: 251–258.
- Canti, M.G. 2003. "Aspects of the chemical and microscopic characteristics of plant ashes found in archaeological soils." *Catena* 54: 339–361.
- Causey, M.J. and Lane, P.J. 2005. "GIS and landscape archaeology: delineating the possible long-term environmental effects of pastoralism on the Laikipia Plateau, Kenya." *Nyame Akuma* 64: 24–32.
- Causey, M.J., 2008. "Delineating pastoralist behaviour and long-term environmental change: a GIS landscape approach on the Laikipia Plateau, Kenya." PhD diss., University of Oxford.
- Causey, M.J. 2010. "New archaeological discoveries from the Laikipia Plateau, Kenya." *Azania: Archaeological Research in Africa* 45: 112–136.
- Childe, V.G. 1936. *Man Makes Himself*. London: Watts & Co.
- Cogdale, J. 2015. "The application of microscopic and micromorphological analysis of dung spherulites to the identification of the species, breeding condition and husbandry style of ruminant domesticates." MSc diss., University College London.
- Courty, M.A., Goldberg, P. and Macphail, R. 1989. *Soils and Micromorphology in Archaeology*. Cambridge: Cambridge University Press.
- Courty, M.A, Macphail, R.I. and Watzel, J. 1991. "Soil micromorphological indicators of pastoralism; with special reference to Arene Candide, Finale Ligure, Italy." *Rivista Di Studi Liguri* 57: 127–150.
- Crumley, C. (ed.), 1994. *Historical Ecology: Cultural Knowledge and Changing Landscapes*. London: Society for American Research Press.
- Dangerfield, J.M., McCarthy, T.S. and Ellery, W.N. 1998. "The mound-building termite *Macrotermes michaelseni* as an ecosystem engineer." *Journal of Tropical Ecology* 14: 507–520.
- Davies, M.I.J. 2013. "Stone cairns across eastern Africa: a critical review." *Azania: Archaeological Research in Africa* 48: 218–240.
- Denevan, W.M. 1992. "The Pristine Myth: the landscape of the Americas in 1492." *Annals of the Association of American Geographers* 82: 369–385.
- Dharani, N. 2002. *Field Guide to Common Trees and Shrubs of East Africa*. Cape Town: Struik.
- Dickson, D.B., Pearl, F.B., Gang, G.Y., Kahinju S., and Wandibba S. 2004. "Site reconnaissance in the Kipsing and Tol River watersheds of central Kenya: implications for Middle and Later Stone Age land-use patterns." *African Archaeological Review* 21: 153–191.
- Donihue, C.M., Porensky, L.M., Foufopoulos, J., Riginos, C. and Pringle, R.M. 2013. "Glade cascades: indirect legacy effects of pastoralism enhance the abundance and spatial structuring of arboreal fauna." *Ecology* 94: 827–837.
- Evans, J.D. 1996. *Straightforward Statistics for the Behavioural Sciences*. Pacific Grove: Brooks/Cole.
- Fox-Dobbs, K., Doak, D.F., Brody, A.K. and Palmer, T.M. 2010. "Termites create spatial structure and govern ecosystem function by affecting N<sub>2</sub> fixation in an East African savanna." *Ecology* 91: 1296–1307.
- Galaty, J.G., 1993. "Maasai expansion and the new East African pastoralism." In *Being Maasai: Ethnicity and Identity in East Africa*, edited by T. Spear and R. Waller, 61–86. London: James Currey.

- Gifford, D.P. 1978. "Ethnoarchaeological observations of natural processes affecting cultural materials." In *Explanation in Ethnoarchaeology*, edited by R.A. Gould, 77–101. Albuquerque: University of New Mexico Press.
- Grillo, K.M. 2012. "The materiality of mobile pastoralism: ethnoarchaeological perspectives from Samburu, Kenya." PhD diss., Washington University in St. Louis.
- Grillo, K.M. 2014. "Pastoralism and pottery use: an ethnoarchaeological study in Samburu, Kenya." *African Archaeological Review* 31: 105–130.
- Hogg, A.G., Hua, Q., Blackwell, P.G., Niu, M., Buck, C.E., Guilderson, T.P., Heaton, T.J., Palmer, J.G., Reimer, P.J. and Reimer, R.W. 2013. "SHCal13 Southern Hemisphere calibration, 0–50,000 cal yr BP." *Radiocarbon* 55: 1889–1903.
- Huete, A.R. 1988. "A Soil-Adjusted Vegetation Index (SAVI)." *Remote Sensing of Environment* 25: 295–309.
- Hughes, L. 2006. *Moving the Maasai: A Colonial Misadventure*. Basingstoke: Palgrave Macmillan.
- Iles, L. and Martínón-Torres, M. 2009. "Pastoralist iron production on the Laikipia Plateau, Kenya: wider implications for archaeometallurgical studies." *Journal of Archaeological Science* 36: 2314–2326.
- Iles, L. and Lane, P.J. 2015. "Iron production in second millennium AD pastoralist contexts on the Laikipia Plateau, Kenya." *Azania: Archaeological Research in Africa* 50: 372–401.
- Jacobs, A., 1965. "The traditional political organisation of the Pastoral Masai." PhD diss., University of Oxford.
- Jungerius, P.D., van den Ancker, J.A.M. and Múcher, H.J. 1999. "The contribution of termites to the microgranular structure of soils on the Uasin Gishu Plateau, Kenya." *Catena* 34: 349–363.
- Kassam, A. 2006. "The people of the five 'drums': Gabra ethnohistorical origins." *Ethnohistory* 53: 173–193.
- Kuehn, D.D., and Dickson, D.B. 1999. "Stratigraphy and noncultural site formation at the Shurmai Rockshelter (GnJm1) in the Mukogodo Hills of north-central Kenya." *Geoarchaeology* 14: 63–85.
- Lane, P.J. (ed.) 2005. *Landscape and Environmental Change in Semi-Arid Regions of East & Southern Africa: Developing Interdisciplinary Approaches*. Unpublished report. Nairobi: British Institute in Eastern Africa.
- Lane, P.J. 2011. "An outline of the Later Holocene archaeology and precolonial history of the Ewaso Basin, Kenya." *Smithsonian Contributions to Zoology* 632: 11–30.
- Lane, P.J. 2013. "The archaeology of pastoralism and stock-keeping in East Africa." In *The Oxford Handbook of African Archaeology*, edited by P.J. Mitchell and P.J. Lane, 585–601. Oxford: Oxford University Press.
- Lane, P.J. 2016a. "Places and paths of memory: archaeologies of East African pastoralist landscapes." In *Cultural Heritage Landscapes in Sub-Saharan Africa*, edited by J. Beardsley, 195–236. Harvard: Harvard University Press.
- Lane, P.J. 2016b. "Entangled banks and the domestication of East African pastoralist landscapes." In *Archaeology of Entanglement*, edited by F. Fernandini and L. Der. 127–150. Walnut Creek: Left Coast Press.
- Lane, P.J., Straight, B. and Hilton, C. 2007. "Excavations at Baawa, Samburu District, Kenya : preliminary report on the 2006 Season." *Nyame Akuma* 68: 34–46.
- Larick, R. 1986a. "Iron smelting and interethnic conflict among precolonial Maa-speaking pastoralists of north-central Kenya." *African Archaeological Review* 4: 165–176.
- Larick, R. 1986b. "Age grading and ethnicity in the style of Loikop (Samburu) spears." *World Archaeology* 18: 269–283.
- Larick, R. 1991. "Warriors and blacksmiths: mediating ethnicity in East African spears." *Journal of Anthropological Archaeology* 10: 229–331.
- Lemoosa, P. 2005. "Pre-colonial ethnic identities." In *Landscape and Environmental Change in Semi-Arid Regions of East & Southern Africa: Developing Interdisciplinary Approaches*, edited by P.J. Lane, 10–12. Unpublished report. Nairobi: British Institute in Eastern Africa.
- Lind, E.M. and Morrison, M.E.S. 1974. *East African Vegetation*. London: Longman.
- Mack, R. 1970. "The great African cattle plague epidemic of the 1890s." *Tropical Animal Health and Production* 2: 210–219.

- Macphail, R.I., Courty, M.A., Hather, J., Wattez, J. and Ryder, M. 1997. "The soil micromorphological evidence of domestic occupation and stabling activities." *Memorie dell'Istituto Italiano di Paleontologia Umana. Nuova Serie* 53–88.
- Maki, D. 2005. "Lightning strikes and prehistoric ovens: determining the source of magnetic anomalies using techniques of environmental magnetism." *Geoarchaeology* 20: 449–459.
- Mbae, B M. 1990. "The ethnoarchaeology of Masaai settlements and refuse disposal patterns in the Lemek area." In *Early Pastoralists of South-Western Kenya*, edited by P.T. Robertshaw, 279–292. Nairobi: British Institute in Eastern Africa.
- McBrearty, S., 1990. "Consider the humble termite: termites as agents of post-depositional disturbance at African archaeological sites." *Journal of Archaeological Science* 17: 111–143.
- McCabe, J.T. 2004. *Cattle Bring Us To Our Enemies: Turkana Ecology, Politics and Raiding in a Disequilibrium System*. Ann Arbor: University of Michigan Press.
- McCormac, F.G., Hogg, A.G., Blackwell, P.G., Buck, C.E., Higham, T.F.G. and Reimer, P.J. 2004. "SHCal04 Southern Hemisphere calibration, 0–11.0 cal kyr BP." *Radiocarbon*. 46: 1087–1092.
- Mehlman, M.J. 1989. "Later Quaternary archaeological sequences in northern Tanzania." PhD diss., University of Illinois at Urbana-Champaign.
- Morris, D.L., Western, D. and Maitumo, D. 2009. "Pastoralists' livestock and settlements influence game bird diversity and abundance in a savanna ecosystem of southern Kenya" *African Journal of Ecology* 47: 48–55.
- Mturi, A. 1986. "The Pastoral Neolithic of West Kilimanjaro." *Azania* 21: 53–63.
- Muchiru, A.N., Western, D.J. and Reid, R.S. 2008. "The role of abandoned pastoral settlements in the dynamics of African large herbivore communities." *Journal of Arid Environments* 72: 940–952.
- Muchiru, A.N., Western, D.J. and Reid, R.S. 2009. "The impact of abandoned pastoral settlements on plant and nutrient succession in an African savanna ecosystem." *Journal of Arid Environments* 73: 322–331.
- Muiruri, V. M. 2008. "Detecting environmental changes and anthropogenic activities on the Laikipia Plateau, Kenya." MSc diss., University of the Free State, Bloemfontein.
- Odner, K. 1972. "Excavations at Narosura, a Stone Bowl site in the southern Kenya highlands." *Azania* 7: 25–92.
- Okullo, P. and Moe, S.R. 2011. "Termite activity, not grazing, is the main determinant of spatial variation in savanna herbaceous vegetation." *Journal of Ecology* 100: 232–241.
- Payton, R., 2005. "Soils, land degradation and landscape history in Laikipia District." In *Landscape and Environmental Change in Semi-Arid Regions of East & Southern Africa: Developing Interdisciplinary Approaches*, edited by P.J. Lane, 48–84. Unpublished report. Nairobi: British Institute in Eastern Africa.
- Posey, D.A. 1985. "Indigenous management of tropical forest ecosystems: the case of the Kayapó Indians of the Brazilian Amazon." *Agroforestry Systems* 3: 139–158.
- Pratt, D.J. and Gwynne, M.D. 1977. *Rangeland and Management of Ecology in East Africa*. London: Hodder and Stoughton.
- Prendergast, M.E., Mabulla, A.Z.P., Grillo, K.M., Broderick, L.G., Seitsonen, O., Gidna, A.O. and Gifford-Gonzalez, D. 2013. "Pastoral Neolithic sites on the southern Mbulu Plateau, Tanzania." *Azania: Archaeological Research in Africa* 48: 498–520.
- Qandelihle, S., 2010. "Temporal and spatial impacts of termites on local soil and vegetation dynamics in a semi-arid savanna ecosystem." PhD diss., University of Newcastle-upon-Tyne.
- Ratnam, J., Bond, W.J., Fensham, R.J., Hoffmann, W.A., Archibald, S., Lehmann, C.A.R., Anderson, M.T., Higgins, S.T. and Sankaran, M. 2011. "When is a 'forest' a savanna, and why does it matter?" *Global Ecology and Biogeography* 20: 653–660.
- Reimer, P.J., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Ramsey, C.B., Buck, C.E., Cheng, H., Edwards, R.L., Friedrich, M. and Grootes, P.M. 2013. "IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP." *Radiocarbon*, 55: 1869–1887.
- Robertshaw, P.T. 1978. "The archaeology of an abandoned pastoralist camp-site." *South African Journal of Science* 74: 29–31.

- Robertshaw, P.T. (ed.), 1990. *Early Pastoralists of South-Western Kenya*. Nairobi: British Institute in Eastern Africa.
- Schlee, G. 1985. "Interethnic clan identities among Cushitic-speaking pastoralists." *Africa* 55(1): 17–38.
- Shahack-Gross, R. 2011. "Herbivorous livestock dung: formation, taphonomy, methods for identification, and archaeological significance." *Journal of Archaeological Science* 38: 205–218.
- Shahack-Gross, R., Marshall, F., Ryan, K. and Weiner, S. 2004. "Reconstruction of spatial organization in abandoned Maasai settlements: implications for site structure in the Pastoral Neolithic of East Africa." *Journal of Archaeological Science* 31: 1395–1411.
- Shahack-Gross, R., Marshall, F.B. and Weiner, S. 2003. "Geo-ethnoarchaeology of pastoral sites: the identification of livestock enclosures in abandoned Maasai settlements." *Journal of Archaeological Science* 30: 439–459.
- Shahack-Gross, R., Simons, A. and Ambrose, S.H. 2008. "Identification of pastoral sites using stable nitrogen and carbon isotopes from bulk sediment samples: a case study in modern and archaeological pastoral settlements in Kenya." *Journal of Archaeological Science* 35: 983–990.
- Siiriainen, A. 1984. *Excavations in Laikipia: An Archaeological Study of the Recent Prehistory in the Eastern Highlands of Kenya*. Helsinki: Suomen Muinais-muistoyhdistyksen Aikakauskirja Finska Fornminnesf renengens Tidskrift.
- Sobania, N. 1993. "Defeat and dispersal: the Laikipiak and their neighbours in the nineteenth century." In *Being Maasai*, edited by T. Spear and R. Waller, 105–119. London: James Currey.
- Sobania, N. 1988. "Fishermen herders: subsistence, survival and cultural change in northern Kenya." *Journal of African History* 29: 14–40.
- Söderström, B. and Reid, R.S. 2010. "Abandoned pastoral settlements provide concentrations of resources for savannah birds." *Acta Oecologica* 36: 184–196.
- Spear, T. 1993a. "Introduction." In *Being Maasai*, edited by T. Spear and R. Waller, 1–18. London: James Currey.
- Spear, T. 1993b. "Being 'Maasai', but not 'People of Cattle': Arusha agricultural Maasai in the nineteenth century." In *Being Maasai*, edited by T. Spear and R. Waller, 120–136. London: James Currey.
- Spencer, P. 1965. *The Samburu: A Study of Gerontocracy in a Nomadic Tribe*. London: Routledge.
- Spencer, P. 1973. *Nomads in Alliance: Symbiosis and Growth Among the Rendille and Samburu of Kenya*. London: Oxford University Press.
- Spencer, P. 2003. *Time, Space and the Unknown: Maasai Configurations of Power and Providence*. London: Routledge.
- Stelfox, J.B. 1986. "Effects of livestock enclosures (bomas) on the vegetation of the Athi Plains, Kenya." *African Journal of Ecology* 24: 41–45.
- Stoops, G. 2003. *Guidelines for Analysis and Description of Soil and Regolith Thin Sections*. Madison: Soil Science Society of America.
- Straight, B., Lane, P.J., Hilton, C., Letua, M. 2015. 'It was *maendeleo* that removed them': disturbing burials and reciprocal knowledge production in a context of collaborative archaeology. *Journal of the Royal Anthropological Institute* 21: 391–418.
- Straight, B., Lane, P.J., Hilton, C. and Letua, M., 2016. "Dust people": Samburu perspectives on disaster, identity, and landscape. *Journal of Eastern African Studies* 10: 168–188.
- Tablino, P. 1999 [1980]. *The Gabra: Cattle Nomads of Northern Kenya* [I Gabbra del Kenya]. Nairobi: Paulines Publications.
- Taylor, D., Lane, P.J., Muiruri, V., Ruttledge, A., Gai McKeever, R., Noland, T., Kenny, P. and Goodhue, R. 2005. "Holocene vegetation dynamics on the Laikipia Plateau, Kenya." *The Holocene* 15: 837–846.
- Turner, B.J. 1967. "Ecological problems of cattle ranching on *Combretum* savanna woodland in Uganda." *East African Geographical Review* 5: 9–19.
- Veblen, K.E. 2012. "Savanna glade hotspots: plant community development and synergy with large herbivores." *Journal of Arid Environments* 78: 119–127.
- Veblen, K.E. 2013. "Impacts of traditional livestock corrals on woody plant communities in an East African savanna." *The Rangeland Journal* 35: 349–353.

- Waller, R. 1979. "The lords of East Africa: the Maasai in the mid-nineteenth century, c. 1840–1885." PhD diss., University of Cambridge.
- Waller, R.D. 1988. "Emutai: crisis and response in Maasailand, 1889–1902." In *The Ecology of Survival: Case Studies from Northeast African History*, edited by D.H. Johnson and D.M. Anderson, 73–113. Boulder: Westview Press.
- Wandibba, S. 1980. "The application of attribute analysis to the study of Later Stone Age/Neolithic pottery ceramics in Kenya (summary)." In *Proceedings of the 8th Panafrican Congress of Prehistory and Quaternary Studies, Nairobi, 5 to 10 September 1977*, edited by L.S.B. Leakey and B. Ogot, 283–285. Nairobi: International Louis Leakey Memorial Institute for African Prehistory.
- Weiss, E. 1989. *Guide to Plants Tolerant of Arid and Semi-arid Conditions: Nomenclature and Potential Uses*. Weikersheim: Margraf.
- Western, D. and Dunne, T. 1979. "Environmental aspects of settlement site decisions among pastoral Maasai." *Human Ecology* 7: 75–98.
- Young, T.P., Partridge, N. and Macrae, A. 1995. "Long-term glades in *Acacia* bushland and their edge effects in Laikipia, Kenya." *Ecological Applications* 5: 97–108.
- Zhang, H., Lan, Y., Lacey, R., Hoffmann, W.C. and Huang, Y. 2009. "Analysis of vegetation indices derived from aerial multispectral and ground hyperspectral data." *International Journal of Agricultural and Biological Engineering* 2(3): 33–40.