

McDONALD INSTITUTE MONOGRAPHS

An Age of Experiment: Classical Archaeology Transformed (1976–2014)

Edited by Lisa Nevett and James Whitley



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with contributions from
Susan E. Alcock, Giovanna Ceserani, Alexandra Coucouzeli, Thomas W. Gallant, Michael Given, Jonathan M. Hall, Paul Halstead, Sturt W. Manning, Ian Morris, Lisa Nevett, Robin Osborne, Sara Owen, Gillian Shepherd, David B. Small, Jeremy Tanner and James Whitley

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Contributors

Professor Susan E. Alcock
Department of Classical Studies, University of Michigan, 2160 Angell Hall, 435 S. State St., Ann Arbor, MI 48109-1003, USA
Email: salcock@umich.edu

Professor Giovanna Ceserani
Department of Classics, Stanford University, 450 Serra Mall, Building 110, Stanford, CA 94305, USA
Email: ceserani@stanford.edu

Dr Alexandra Coucouzeli
Darwin College, Silver Street, Cambridge CB3 9EU, UK
Email: alexandra.coucouzeli@cantab.net

Professor Thomas W. Gallant
Center for Hellenic Studies, 0104 Department of History, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0104, USA
Email: tgallant@ucsd.edu

Dr Michael Given
Archaeology, School of Humanities, University of Glasgow, Glasgow G12 8QQ, UK
Email: Michael.Given@glasgow.ac.uk

Professor Jonathan Hall
Department of History, University of Chicago, 1126 E 59th St., Chicago, IL 60637, USA
Email: jhall@uchicago.edu

Professor Paul Halstead
Department of Archaeology, University of Sheffield, Minalloy House, 10-16 Regent Street, Sheffield S1 3NJ, UK
Email: p.halstead@sheffield.ac.uk

Professor Sturt W. Manning
Department of Classics, Cornell University, 120 Goldwin Smith Hall, Ithaca, New York 14853, USA
Email: sm456@cornell.edu

Professor Ian Morris
Department of Classics, Stanford University, 450 Serra Mall, Building 110, Stanford, CA 94305, USA
Email: imorris@stanford.edu

Professor Lisa Nevett
Department of Classical Studies, University of Michigan, 2160 Angell Hall, 435 S. State St., Ann Arbor, MI 48109-1003, USA
Email: lcnevett@umich.edu

Professor Robin Osborne
Faculty of Classics, University of Cambridge, Sidgwick Avenue, Cambridge CB3 9DA
Email: ro225@cam.ac.uk

Dr Sara Owen
Fitzwilliam College, University of Cambridge, Storey's Way, Cambridge CB3 0DG, UK
Email: sso10@cam.ac.uk

Dr Gillian Shepherd
Faculty of Humanities and Social Sciences, La Trobe University, Melbourne (Bundoora) 3086, Australia
Email: g.shepherd@latrobe.edu.au

Professor David B. Small
Department of Sociology & Anthropology, Lehigh University, 681 Taylor St., Bethlehem, Pennsylvania 18015, USA
Email: dbs6@lehigh.edu

Professor Jeremy Tanner
Institute of Archaeology, University College London, 31–34 Gordon Square London WC1H 0PY, UK
Email: j.tanner@ucl.ac.uk

Professor James Whitley
School of History, Archaeology and Religion, Cardiff University, Colum Road, Cardiff CF10 3EU, UK
Email: WhitleyA@Cardiff.ac.uk

Chapter 11

The Sh** That You Find on the Surface: Manuring and Field Survey in the Mediterranean Countryside

Paul Halstead (Sheffield University)

The Cambridge/Bradford Boeotian Expedition (CAB-BAGE), which Anthony Snodgrass co-directed, pioneered the recording of off-site material by field survey projects in Greece with two aims: to define surface hotspots or 'sites' more rigorously (Bintliff and Snodgrass 1985) and to map land use (Bintliff and Snodgrass 1988; Snodgrass 1982, 808; 1990; 1994, 199–200). Realization of the latter aim presumed that middening (spreading manure mixed with domestic refuse to fertilize fields) was a major source of the dense surface 'halos' observed around many sites. This 'middening hypothesis' underpinned Snodgrass' cogent interpretation (1990, 122–7) of small rural sites with halos in Classical Boeotia as 'farmstead' bases for arable farming. It also underlies arguments on such diverse issues as the scale and form of cultivation around Late Bronze Age settlements on southern Aegean Kithira (Bevan 2002), the changing balance between crop and livestock husbandry with increasing altitude on the southern Greek Methana peninsula (Mee and Forbes 1997, 40), the agricultural self-sufficiency of Early Bronze Age towns in northern Mesopotamia (Wilkinson 1994), and the nature of land tenure around Roman rural sites in southeast England (Williamson 1988).

The linkage between off-site ceramic scatters and middening or manuring has been questioned, however, not least by survey archaeologists working in Greece. Thus Alcock *et al*. (1994) questioned the importance of middening in the ancient Mediterranean on two grounds: that manure was (paradoxically) both scarce and potentially deleterious to crops; and that other practices and processes (acknowledged by Bintliff and Snodgrass 1988, 507–8) have significantly shaped the deposition and subsequent modification of off-site ceramic scatters. The following two sections draw largely on first-hand observation and interviewing of 'traditional' non-mechanized farmers in Mediterranean Europe to explore, first, the agronomic feasibility and potential benefits of ancient middening/manuring and, secondly, possible archaeological formation processes (excluding post-depositional transformations) shaping off-site scatters.

Agronomic (in)feasibility: too much and too little manure

Manure and manuring in 'traditional' Mediterranean farming

I have not encountered an elderly (ex-)farmer, among hundreds interviewed across Mediterranean Europe, who did not understand the need for cultivated land to be rested or fertilized to remain productive. Prior to the recent adoption of industrial fertilizers, farmers rested much more of their land in short-term 'bare' (cultivated) or weedy (uncultivated) fallow, but also ploughed in 'green manure', silt, ash, leaf mould, domestic or garden compost, industrial waste and manure (e.g. Loukopoulos 1983, 178–9). Of these measures, fallowing and manuring were most widespread in geographical coverage, number of practitioners, and area treated.

Cultivated land was manured in three principal ways: by livestock grazing fallow and stubble fields; by livestock folded (penned) in gardens or fields, especially overnight in summer; and by farmers spreading manure from animals stalled overnight or over winter. Although the rate and frequency of application by each method varied greatly, geographically diverse estimates (Halstead 2014, 222–3 Table 5.1) suggest order-of-magnitude increases in manuring intensity from grazing to folding to spreading stall manure. Moreover, interviewees rarely describe dung from grazing livestock as deleterious (as a source of unwelcome weed seeds), but routinely emphasize potential harm to crops from folding and especially stall manure.



Figure 11.1. *'Lodged' (fallen) wheat in the middle of a field near Kolindros in northern Greece (June 2016) (photo Paul Halstead).*

Heavy manuring promoted vigorous crop growth, with potentially harmful consequences that depended on rainfall and temperature, and thus latitude. In the north Mediterranean, including northern Greece, vigorous growth increased the risk to autumn-sown crops of more or less severe yield reductions from late frosts and, especially following a wet spring, from cereal stem collapse or 'lodging' (Fig. 11.1). Further south, vigorous growth might exceed water supply and manure might even 'burn' plants (Halstead 2014, 193–5, 213–14), again reducing yields.

Responses to these risks also varied with latitude. Northern farmers often deliberately retarded crop growth on fertile land by sowing late or encouraging 'tillering' (multiple shoots from a single seed) rather than vigorous vertical growth. They promoted tillering variously by sowing sparsely, harrowing sprouting cereals, or grazing/cutting cereals at shin height (before the ear emerged). Further south, where autumn rains were later and sparser, sowing was delayed and often lighter, while preventive grazing or cutting of cereals was less common because moisture was insufficient for crops to recover; here farmers spread manure much more sparsely (Halstead 2014, 214–29).

In northern and southern Mediterranean Europe alike, farmers understood the risks posed by manure, but recognized that it improved soil tractability, crop quality (e.g. faster cooking pulses), and especially crop yields. Accordingly, they manured fields while seeking to minimize negative side effects. Manure releases nutrients more slowly than industrial fertilizers and is harder to distribute evenly and sparsely, so short-term losses (usually affecting the first crop after application) were accepted as the price of long-term benefits (over several years and cumulatively over decades). Nor were short-term side effects invariably negative: cereals grazed to control excessive growth provided valuable 'early bite' pasture for lactating ewes and she-goats and, especially in the north, some land was heavily manured expressly for this purpose.

Aware of both benefits and risks, recent practitioners ideally applied manure where and when it did most good and least harm, especially on infertile and, in the drier south, irrigated land, but were usually constrained by availability or difficulty of distribution. Manure was bulky and heavy, even when rotted and drained. Draught or pack animals often carried it just a few hundred metres and rarely more than 2–3 km in northern Greece (Halstead 2014, 217–18), although perhaps further in the south thanks to lighter application (Forbes 2013, 570). Distant fields, unless near outlying folds or byres, were routinely treated only following adoption of industrial fertilizer.

Before mechanization, dung from byres was sometimes tipped into nearby gullies, because transport to distant fields was prohibitively difficult and not because it was unwanted. On the contrary, despite a propensity to buy nothing they could produce

themselves, informants routinely cited abundance as a great advantage of industrial fertilizer over manure. Nor did lighter application create a surfeit in southern Greece, where farmers seemingly had much less stall manure than their northern counterparts. In the south, stall-feeding of large livestock was more difficult, because of smaller grain and straw harvests, and more avoidable, thanks to milder winters. Southern farmers were also less inclined to expand stall manure with urine-soaked litter (Forbes 2013, 569), perhaps partly because the latter was particularly likely to cause excessive growth or burning. Moreover, many owned only a donkey or two and a handful of house-goats or -sheep kept for milk.

Many informants on southern Greek Crete and Kithira restricted stall-manure to watered gardens (Fig. 11.2) and, very sparingly, vines and olives. Some also commented on the risks of manuring cereals, but cited examples implying that either they or their neighbours had done so. Other accounts explicitly attributed restricted application to scarcity (e.g. Blitzer 2004, 193; Halstead 2014, 225). With two oxen and a few sheep, Sofia's father in 1930s Aloides, central Crete, only had enough manure for his garden (sown with wheat the following year) and vines. Similarly, Ilias at Metaxada in the Messinian hills had two draught cattle and a few sheep or goats and only fertilized one of his poorest cereal fields if manure remained after he had treated his gardens, olives and vines. At Kastrisianika on Kithira, Panagiotitsa and her husband kept two donkeys, three sheep and one goat and manured only their gardens and olives. Her neighbours Thanasis and Froso, with two donkeys and ten sheep or goats, sometimes also treated a field or two because many of their olives were 8–10 km away and so too distant. Farmers rarely share the burning need of archaeologists and historians to decide whether distribution of manure was dictated by scarcity or fear of negative effects, since both factors were usually important. Manure could harm vines, olives and even vegetables, however, as well as annual crops, and some informants made clear that the former were prioritized for treatment because the scarce manure from a handful of animals could improve small gardens and vineyards



Figure 11.2. *Stall manure spread evenly across part of a garden plot (right foreground) at Axos, central Crete (July 2016); the garden is irrigated (temporary channels from a previous crop are still visible at centre rear) (photo Valasia Isaakidou).*

and small numbers of trees, but would have little effect in larger fields.

The availability and use of manure in the recent past differed not only between north and south but also somewhat between large and small arable holdings. Those with larger holdings could 'rest' fields in regular fallow, as the most labour-efficient means of controlling weeds and maintaining fertility, while those with smaller holdings necessarily practised more labour-intensive rotations with little fallowing and greater dependence on manure for fertility. Large landowners, however, generally had more livestock and so more manure, with work animals and perhaps carts and dependent labourers to facilitate its distribution, although those in north Greek Assiros, at least, concentrated their stall manure on in-fields devoted to early-bite pasture – more productive sheep afforded better returns for less effort than higher wheat yields. The owners of big Ottoman-era estates in central and northern Greece also attracted huge transhumant flocks to their fallow fields in winter, benefitting from their dung as well as the payment of grazing fees (Karavidas 1931). Inequalities of land tenure thus complicated and blurred regional contrasts in availability and application of manure.

Manure and manuring in antiquity

Recent farming practice in the pre-mechanized Mediterranean supports the claim of Alcock *et al*. (1994) that manure can be both harmful to crops and scarce. Much recent folk wisdom on mitigating the negative effects of manuring is matched in Theophrastos' writings: prioritize poor land for treatment (*On the Causes of Plants* 3.20.2), provided rainfall is sufficient (*On the Causes of Plants* 3.9.2); combine manuring with watering of gardens (*On the Causes of Plants* 3.9.2); spread manure moderately, especially in dry conditions (*On the Causes of Plants* 3.9.2, 5.15.2–3); and limit vigorous vegetative growth of cereals (which manure promotes – *Enquiry into Plants* 8.7.7) by early preventive grazing or cutting (*Enquiry into Plants* 8.7.4). Written sources leave no doubt that manure *was* spread on cultivated land, while literary references to collection of scattered dung and epigraphic proscriptions against its unauthorized removal show that it was valued (Alcock *et al*. 1994, 152, 154).

The sparse epigraphic evidence for scale of animal husbandry in classical Greece also unequivocally supports the argument of Alcock *et al*. (1994) that even the wealthy elite of southern Greece owned modest numbers of livestock. Panaitios in late fourth-century BC Athens, probably a man of elevated status, apparently owned four oxen, four cows with their calves, 84 ewes with their lambs and 67 goats with their kids (Pritchett 1953, 268–79; Chandezon 2003, 17–21) – a number of livestock matched, especially in northern Greece, by mid-twentieth-century farmers of comfortable rather than exceptional means (e.g. owning no more cultivable land than an Athenian hoplite – cf. Foxhall 1992). Panaitios' less prosperous fellow citizens, who are barely represented epigraphically, presumably maintained very few livestock indeed; apparently contradictory Classical injunctions (again from the southern Aegean) against dumping manure arguably reflect not its abundance but its prohibitive transport costs.

Alcock *et al*. (1994) explore the likely scale of manuring for three farming households of varying composition: an extended family of ten persons with two oxen, ten sheep/goats, one pig and ten chickens, as described for Euboea by Dio Chrysostom (*Discourses* 7, *The Euboean Discourse*); hypothetical five-person household A with one ox, 12 sheep/goats, two pigs and ten chickens; and hypothetical five-person household B with only ten sheep/goats and five chickens (1994, 154 table 8.1). Using figures for modern west European livestock, they estimate an annual output of fresh manure (human and animal combined) of 45 tons for the 'Euboean' household, 31 tons for household A, and 9 tons for household B, in each case considered equivalent to less than half as much by weight of rotted manure. Assuming application rates comparable with those recommended for modern (mechanized) agriculture in Italy (40–60 m^3 per ha), cited by Spurr (1986, 126 n18), they suggest that each year the 'Euboean' household could have treated 1–3 ha, household A 0.6–2.0 ha, and household B 0.2–0.6 ha. Further assuming holdings of 5 ha, 5 ha and 2 ha, respectively, the 'Euboean' household could annually have manured 20–60 per cent of its land, household A 12–40 per cent, and household B 9–30 per cent (Table 11.1). 'However tentative, these figures show the restricted scale of the manuring that was feasible for households of this size' (Alcock *et al*. 1994, 153–4).

This pessimistic conclusion is questionable on several grounds. First, a dressing of 40–60 m^3 per ha, even if of fresh manure (possible with mechanization) and thus equivalent to only 16–24 tons per ha, seems excessively risky for unirrigated crops in the southern Aegean. Secondly, extrapolating from recent pre-mechanized tillage in Greece (Halstead 2014, 42–7), the 'Euboean' household may have cultivated about 5 ha if its two draught 'oxen' were castrated males, but perhaps only 2–3 ha if they were dual-purpose cows. Household A is unlikely to have cultivated more than 1–2 ha with a single 'ox' (of necessity yoked with that of a neighbour and so available part-time), while household B, with no 'ox', could only have cultivated

Table 11.1. *Estimates of manure output and use by Alcock et al. (1994) for three modest model households, with suggested revisions and possible comparative data for the wealthy household of Panaitos.*

		Alcock et al.			
		Euboean household	**'Household A'**	**'Household B'**	**Panaitios**
Alcock *et al*. estimates	persons	10	5	5	?10
	cattle	2	1		4
	sheep/goats	10	12	10	151
	pigs	1	2		
	hens	10	10	5	
	manure output (tons)	45	31	9	246
	area treated/yr (ha)	1–3	0.6–2	0.2–0.6	5.5–16.0
	total land area (ha)	5	5	2	10
	% land treated/yr	20–60	12–40	9–30	55–160
Revised estimates	area treated/yr (ha)	1–3	0.6–2	0.2–0.6	5.5–16.0
	total land area (ha)	3	2	1	10
	% land treated/yr	33–100	30–100	17–60	55–160

its proposed 2 ha by hand at the most favourable points in the domestic cycle (cf. Gallant 1991). With lower land allocations of 3, 2 and 1 ha, respectively, the exemplar households could have manured 33–100 per cent, 30–100 per cent, and 17–60 per cent of their land, respectively, each year. (Panaitios could have manured 55–100 per cent of his land annually, even if he cultivated 10 ha with his two pairs of oxen, only one of which is designated as 'working'.) In practice, ethnographic data from northern Greece strongly favour the lower end of these ranges, although the upper end may be more plausible for southern Greece where manure was spread more sparsely (see below). Thirdly, because manure releases nutrients gradually and is difficult to spread evenly and sparsely, it was traditionally applied to individual cereal fields at intervals of several years. Conversely, the revised figures just presented suggest that the 'Euboean' and A households could have dressed fields with 16–24 tons per ha of fresh manure every one to three years. Such intensive manuring was matched in recent 'horticultural' rotation of glume wheat with nutrient-hungry maize or potato in rainy Asturias, northwest Spain, and in sown 'early-bite' pasture in northern Greece, but would be inconceivable outside well-watered vegetable gardens in the southern Aegean (Halstead 2014, 219–26). It would be foolhardy to insist that Classical farmsteads could manure their cultivated land intensively, but these revised calculations highlight the fragility of the opposing argument advanced by Alcock and colleagues.

One obvious caveat, as Alcock *et al*. note, is that grazing livestock would have voided much of their dung directly on gardens, fields and perhaps uncultivated land, so the figures above overestimate the stall manure available for spreading (perhaps with discarded artefacts) by human hand. In the southern Aegean, given mild winters and perhaps limited fodder, cattle, sheep and goats probably spent at least half of their time (perhaps much more in the predator-free islands, where they could more safely remain unpenned at night) away from byres. On this basis, the three exemplar households are likely to have produced no more than 24, 19 and 5 tons of fresh (or less than half as much rotted) stall manure, respectively, and to have spread this and any pottery fragments on a correspondingly reduced area of land (below).

On the other hand, as in the recent past, livestock and manure may have been significantly more abundant in the fertile and wetter lowlands of central and northern mainland Greece than further south. Even without seasonal transhumance to mountain pastures, the central and northern mainland had more extensive wetlands, while its crops will have produced more straw for cattle and its fallow and stubble fields more nutritious weeds for small stock. Among several literary sources implying that this pastoral potential was exploited in central Greece (Howe 2008, 69–70), Xenophon (*Hellenica* 6.4.29) describes Jason of Pherae easily mobilizing 1000 cattle and more than 10,000 sheep, goats and pigs for sacrifice at Delphi in 370 BC. Similarly, a third-century BC inscription records the right of Elateian Eubolos to graze 1000 small stock (sheep, goats) and 220 large (cattle, horses) on public pasture of Boeotian Orchomenos (Dittenberger [*IG* VII] 1892, 3171; Chandezon 2003, 41–5). Further north, in lowland Macedonia, the second-century BC inscription of the city of Morrylos thanking Alketas for a gift of

'herd cows' hints that large as well as small stock were managed on a scale exceeding household needs (Pleket & Stroud [*SEG* 39] 1989, 605; Chandezon 2003, 97–102). With more livestock stalled for longer over winter, Classical farmers in central and northern Greece probably had far more stall manure than their southern counterparts. Perhaps significantly, Theophrastos describes repeated grazing or cutting of cereals (evidently grown for grain) on good soils to prevent excessively vigorous growth (and thus possible lodging) *'as in Thessaly'* (Theophrastos *Enquiry into Plants* 8.7.4). In traditional farming in northern Greece, cereals yielded a grain crop following *repeated* early grazing or cutting only on the most fertile land – normally in the first year after heavy manuring (Halstead 2014, 193–5, 221–4).

In traditional Mediterranean farming, from the wetter north to more arid south, decreasing availability of manure and increasing risk of it harming crops together resulted in progressively sparser application. A similar regional trend probably obtained in classical antiquity, but Alcock *et al*. modelled land use around classical Greek 'farmsteads' combining ancient written accounts of livestock and manure in an overwhelmingly southern Greek context with modern manuring rates from the north Mediterranean. They thus exaggerated both the scarcity of manure and risks of its application in antiquity. Manure probably was scarce (i.e. availability limited use), difficulties of transport doubtless further constrained its application, and sometimes it will have caused short-term harm to crops, but there is no reason to imagine, as do Alcock *et al*., that these factors prevented its widespread and routine application, albeit at lower intensities and over shorter distances than farmers might have desired.

We plough the fields and scatter sherds?

Refuse disposal in the recent past

While livestock may void manure directly on cultivated land, human spreading of stall manure is far more likely also to disperse discarded material culture, such as the carrier bags and plastic bottles visible today among dung piled in stubble fields or orchards. Manure spread from outlying byres, used perhaps fleetingly by a few herders for particular tasks, should also be much poorer in cultural inclusions than that from stalls close to more permanent human habitations, where refuse from more diverse activities is discarded (Alcock *et al*. 1994, 152–3). Even in the latter case, however, the likelihood of cultural items being mixed with stall manure, or other refuse used as fertilizer, is highly variable (Forbes 2013).

Informants from rural locations as disparate as Potamia (Messinia) and Khora (Naxos) in southern Greece, Tharounia (Euboea) in central Greece, Assiros and Paliambela-Kolindrou (Macedonia) in northern Greece, and Zureda (Asturias) in northern Spain have stressed how rarely items of durable material culture were discarded in the early to middle twentieth century AD (also Forbes 2013, 568). Valentina at Zureda offers a fairly typical account (also Forbes 2013, 565–6): 'ash from the hearth went on the dung heap, vegetable peel was fed to the pig or hens, bones given to the dog, house-building rubble used as hardcore on muddy paths, and rare tin cans or broken plates thrown in the ravine below the house.' Inevitably, such normative descriptions mask more variable practice. On in-field plots bordering Llanos de Somerón village near Zureda, recent inspection found ash, animal bone and broken china discarded independently of rows of piled stall manure. In northern Greek Assiros, Vasilis accumulates stall manure from a few goats and cows at the end of the yard furthest from his house. He discards fruit and vegetable peelings here for his hens to pick over, but public refuse collectors remove other domestic waste. His neighbour, Tasoula, finds the dung heap offensive, but grew up in a yard where her mother added compost and occasional broken plates to dung accumulated from the stalled cattle and household pig. Conversely, in the parental home of her husband Yannis, broken plates were dumped in the adjacent stream, so they did not impede spreading of dung (bovine mixed with human) as fertilizer. At Paliambela-Kolindrou, another Yannis recalls that his parents avoided throwing artefactual refuse on the dung heap in their yard, but that some neighbours were less 'house-proud' (*noikokuraíoi*). Mitsos too dumped domestic refuse not on the manure heap but on whatever field he was working in each day.

On Crete, Sofia's mother at Aloides swept out the byre every morning into a pit in the yard, where she also threw ash from the hearth and other (unspecified) domestic refuse, while villagers in the Cretan Mesara listed broken crockery among items consigned to the dung pit or *koprólakkos* (Blitzer 2004, 193). Conversely, elderly informants from Ayia Anastasia, Aroniadika, Progki, Fatsadika and Kastrisianika on Kithira uniformly insist that broken china or glassware was thrown into ravines, patches of maquis or rubbish pits, because mixed with manure or compost destined for gardens or fruit trees it would have cut household members' hands or feet (also Forbes 2013, 567).

Such anecdotal evidence is difficult to quantify and, for both practical and cultural reasons (also Forbes 2013), even close neighbours varied in their treatment of different categories of waste. The implication that southern Greek villagers less frequently mixed china with manure is plausible, because they often spread

the latter *by hand* to ensure sparse and even coverage that would not harm crops, whereas their north Greek counterparts spread it more thickly with a fork or shovel. Kithiran garden surfaces do contain ceramic fragments from recent centuries, however, and elderly informants' reports of cautious discard may partly reflect recent use of *glass*ware and *metal* cans (cf. Forbes 2013, 574).

In addition to concerns about injury to household members, the proximity of human residence to animal byres and manure heaps also surely affected the likelihood of artefactual refuse being mixed with manure. In north Greek villages or neighbourhoods founded in the 1920s by refugees from Turkey (e.g. Paliambela-Kolindrou), houses were usually set in large yards together with byres for draught animals, the household pig and perhaps a few cows or sheep for milking. Stall manure might be removed from these yards piecemeal, if the householder had a suitable field nearby and winter rain had not made tracks impassable by cart, but it often accumulated until summer when it had lost much of its weight and the tracks were dry. Older settlements were typically much more densely built-up, so that houses and byres might not be adjacent and the accumulation of middens might be precluded by lack of space or desire to avoid smells. Thus in the small town of Kolindros, overlooking Paliambela, Vasilis' father stalled his single donkey next to the house, but took the manure directly to his vineyard outside the village. Mid-twentieth-century Assiros, a long established village, was more crowded than Paliambela, but less so than Kolindros. A few wealthy households stalled several cattle and horses in the village, carting the manure to their fields in summer. Over winter, Yannis' parents accumulated the manure in their yard but others had their farmhands move it every morning to middens on the village outskirts. These wealthy villagers also owned the larger sheep and goat flocks that spent winter and spring in folds at the edge of the village's arable land. In southern Greece, at Kithiran Kastrisianika, Mikhalakas' 240 m^2 plot contained his house, an older house that sheltered his two draught cattle, a flimsier stall for his donkeys and house-goats, and a stone basin for manure from which the liquid fraction could be drained directly onto his garden. His neighbours' house occupied a plot four times larger, but they kept only hens here and stalled their larger animals in the empty house of deceased relatives 100 m away – presumably to avoid odours and flies. Other things being equal, presumably, household refuse was more frequently mixed with manure when house, byre and midden shared the same yard – that is in lightly rather than densely occupied settlements and in the case of smallholders (with few livestock housed close to home) rather than wealthy landowners (with larger numbers of livestock perhaps stalled or penned at a distance) or landless labourers (some with no livestock at all).

Refuse disposal and middening in antiquity

The degree of (dis)association between stall manure and durable artefactual refuse in the recent past was evidently affected by several variables, that must also be considered in interpreting ancient off-site surface scatters. To explore the significance of these complicating variables, their potential contributions are next considered to two aspects of the off-site surface record from Greece: (a) the regional contrast between northern Greece, where the Langadas Basin Survey found almost no trace of pre-Ottoman off-site scatters (Andreou and Kotsakis 1999), and southern Greece, where such scatters are *more or less* richly documented (e.g. Forbes 2013, 576–7); and (b) the marked and widely observed peak in density of southern Greek off-site scatters in Archaic or Classical to Early Hellenistic times (e.g. Alcock *et al*. 1994, 164–5; Alcock 2007, 135).

First, the hazards of excessive manuring must always – for climatic reasons – have been greater in the south than the north, favouring sparser manual application and greater care to discard obstructive or sharp ceramic fragments separately in the former region. This accentuates, however, rather than accounting for, the contrasting off-site densities of southern and northern Greece. Secondly, the quantity of durable and diagnostic material culture discarded in the past surely varied over time (e.g. Rutter 1983; Bintliff 2005), between regions, and between social groups of contrasting wealth. For example, if the strikingly low *on-site* surface densities encountered in the northerly Langadas survey (Andreou and Kotsakis 1999, 39) reflect far lesser rates of ceramic consumption than in southern Greece, this may partly account for the contrast between sparser northern and denser southern *off-site* scatters. In the south, diachronic shifts in the relative abundance of ceramic types include significant changes in such practical variables as function, size and technology (e.g. Dibble 2010) and so doubtless also in use life, but estimation of temporal trends in per capita discard of diagnostic pieces would be challenging and anyway seems unlikely to account for much of the sometimes dramatic peak in Classical–Early Hellenistic off-site scatters. Thirdly, literary and epigraphic evidence suggests rising Classical–Hellenistic concern with private and public cleanliness (Lindenlauf 2004) that *might* have encouraged particularly thorough removal of urban refuse to the countryside. Refuse disposal, however, *without* mixed midden material spread as fertilizer, would arguably have created linear

distributions along routeways or gullies convenient for dumping rather than the observed carpets of artefacts.

By default, diachronic variation in off-site scatters in the south, and perhaps the contrast between north and south, are at least partly attributable to temporal and regional differences in the spatial organization of animal penning and thus, probably, in the size and residential density of settlements and the scale and spatial organization of animal husbandry. Here, with the partial exception of settlement size and density, we encounter fairly fundamental 'known unknowns', so what follows is rather speculative. Of the households for which Alcock *et al*. estimated potential manure outputs, that from Euboea described by Dio Chrysostom possessed two oxen, ten sheep/goats, one pig and ten chickens, while hypothetical Households A and B had even fewer. In the recent past, such numbers would normally have been housed close to home, to facilitate regular access (for work, feeding, milking) and because they could find sufficient pasture on nearby gardens, field edges, and waste patches. By contrast, the 84 ewes plus lambs and 67 goats plus kids attributed epigraphically to Athenian Panaitios (let alone the 1000 small and 220 large stock of Elateian Eubolos) would have been penned in summer on stubble fields (and perhaps seasonal wetlands) and in winter perhaps in outlying folds for access to fallow fields and rough pasture. Thus farmers with a few livestock, such as Alcock *et al*. modelled, may (at least in a rural setting) have had greater opportunity than wealthier counterparts, such as Panaitios or Eubolos, to mix domestic ceramic refuse with manure destined for spreading on cultivated land.

This argument sits comfortably with the suggestion that the Classical–Early Hellenistic peak in both off-site scatters and small rural 'farmsteads' in southern Greece reflects relatively egalitarian land ownership and small-scale intensive land use, while the Early Roman decline in both off-site scatters and small rural sites marks more extensive land use and larger agricultural estates (e.g. Alcock 2007; Bintliff *et al*. 2007, 178–9). In the latter period, the decline in off-site scatters might plausibly be attributed to extensive cereal-fallow agriculture (with less need for manuring) and/or to estate owners accumulating large herds that they overwintered away from significant sources of domestic refuse. In the former period, the apparent spacing of 'farmsteads' 500 m or less apart in Boeotia and 250–400 m apart in the Nemea Valley area of the north Peloponnese implies potential territories (assuming consolidated, symmetrically distributed landholdings) of 125–250 m radius covering 5–15 ha (Alcock *et al*. 1994, 163; Snodgrass 1990, 125). In the recent past, manure was sometimes carried over such distances by barrow or human back, but this was much easier and more frequent with draught or pack animals. In practice, ancient arable holdings of 5–15 ha would have needed draught cattle: one pair (possibly shared with a neighbour if half of the land was fallowed each year) to plough 5 ha and at least two pairs (even with alternate fallow) for 15 ha. On the other hand, even with a ten-year application cycle (plausible in the light of recent practice), it is questionable whether manure from two draught cattle would have sufficed to treat 5 ha. The capacity of such 'farmsteads' to manure their hypothetical territories thus arguably depended on how many livestock they maintained in addition to draught cattle. Variability in this respect offers one plausible pre-depositional explanation for the apparent contrast between a continuous off-site 'carpet' in Classical–Early Hellenistic Boeotia and patchier coverage in the Nemea area. Finally, if Boeotian 'farmstead' owners did exploit 5–15 ha of land middened more or less wholesale, they arguably maintained several smaller livestock in addition to the draught cattle needed for tillage and so, by the standards of Classical Athens, would have been fairly wealthy.

Conclusions

Snodgrass' interpretation of the off-site scatters encountered by intensive survey projects in Greece, as the product of middening/manuring, has been hotly disputed. The ethnographic data presented here, drawn from climatically more diverse regions of Mediterranean Europe than hitherto, offers comfort to both sides of the argument.

Recent pre-mechanized farming in Mediterranean Europe differed significantly between the semi-arid south and the cooler and less arid north, where stall manure was more abundant, its potentially negative side-effects on crops less severe, and thus its application heavier. By adopting northern data on the application of manure to arable land, therefore, Alcock *et al*. greatly exaggerate both the scarcity of manure and its potentially deleterious consequences in early historic southern Greece and thus create a misleadingly minimalist impression of the importance of manuring in antiquity.

On the other hand, the evidence presented here supports the insistence of Alcock *et al*. on the complexity of the association between manure and domestic refuse. Broken artefacts are far less likely to accompany dung deposited by grazing livestock, and probably also that spread by people from outlying folds, than manure from animals stalled close to long-term human habitation. Moreover, the inclusion of artefacts in such stall manure is partly shaped by cultural attitudes to

refuse. Despite these complex formation processes, this author is more optimistic than Alcock *et al*. of our ability to interpret off-site scatters. Post-depositional processes have probably obscured rather than created off-site scatters, except on a very local scale. There thus seems no reason to doubt that the widespread off-site scatters in Boeotia result primarily from middening and thus support Snodgrass' interpretation of most Classical–Early Hellenistic small rural sites in that region as farmsteads from which land was cultivated fairly intensively over a radius of up to 250 m or so. Further modelling of the nature and scale of arable land use and associated stock husbandry undertaken from these sites may begin to clarify the likely status, at least in economic terms, of their owners. Apparently absent or sparse off-site scatters are more ambiguous, given complex formation processes, but their interpretation in Early Roman southern Greece, by both supporters and critics of the middening hypothesis, as the product of increasingly inegalitarian land ownership is highly plausible, given other indications of such a trend. More generally, the relative scarcity of off-site scatters in northern Greece, and their variable density in southern Greece, may substantially reflect regional and temporal differences in where animals were penned and thus in the density of human habitation and in the nature and scale of animal husbandry.

In this respect, the recording of off-site scatters exhibits a now familiar trajectory for methodological developments in archaeology: initial optimism, then disappointment that formation processes are more complex than first hoped, and finally realization that disentangling of this complexity may enhance the archaeological record's potential to an unhoped-for degree. A particularly relevant example is the demonstration that raised stable nitrogen isotope ratios in human bone may result from the consumption not only of high levels of animal food, but also of heavily manured plant foods (Bogaard *et al*. 2007). Thanks to this insight, it now seems that intensive manuring has been practised at Koufovouno in southern Greece since the Neolithic and that, as in the recent past, wheat was systematically prioritized for treatment over barley (Bogaard *et al*. 2013). While isotopic analysis of charred grains may identify *which* crops were intensively manured, however, it cannot as yet identify *where* this took place. Biochemical and geochemical analyses at present seem better suited to tracing faecal inputs (and perhaps identifying the taxon of origin) in buried soils or to locating middens, byres or intensively fertilized gardens in and around sites than to revealing patterns of land use on a landscape scale (e.g. Bull *et al*. 1999; Mee and James 2000). Dental microwear and stable isotope analyses of animal teeth and bones are beginning to shed complementary light on the dietary regimes and perhaps mobility of ancient livestock in Greece (Mainland and Halstead 2005; Rivals *et al*. 2011; Vaiglova *et al*. 2014), but their results are not easily anchored in space. These various analytical tools offer complementary insights into past land use and do not as yet duplicate or render redundant the information that can be gleaned from off-site surface scatters. The ultimate prize of such multi-strand investigation is a much richer understanding not only of land use but also of the more or less uneven patterns of land and livestock ownership from which the social fabric of ancient Greece was woven.

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Editors:
Lisa Nevett is Professor of Classical Archaeology at the University of Michigan, Ann Arbor, where she teaches courses on the archaeology of ancient Greek society in the first millennium BC. Her research focuses on using the archaeological remains of Greek settlements of that period as a means of understanding social and economic life, particularly at the scale of the individual household.

James Whitley teaches Classical Archaeology and Archaeological Theory at Cardiff University, where he is Professor in Mediterranean Archaeology. His particular expertise lies in Iron Age and Archaic Greece, particularly Crete. Between 2002 and 2007 he was Director of the British School at Athens.

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