

The domestication of southwest Asian ‘farmyard animals’: Possible insights from management of feral and free-range relatives in Greece

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ABSTRACT

Understanding early animal domestication is complicated by disagreement over what, in cultural terms, differentiates domestic (closely managed? privately owned?) from wild and by the difficulty of distinguishing these categories zooarchaeologically. We describe recent feral populations of goats, sheep, cattle and pigs in Greece, comprising descendants of animals escaped or released from controlled domestic herds but remaining in private ownership. Many such animals are systematically exploited for meat by trapping or driving, while provision of fodder or water, especially as bait for traps but also to shape their movements, blurs the distinction between wild and domestic. Selective culling (mainly of young males) of goats, sheep and cattle confirms previous concerns regarding zooarchaeological use of mortality data to detect domestic management but also suggests that such data might help to identify private ownership of animals. Applying these observations to mortality data for goats and sheep from early Neolithic southwest Asia, we argue that some animals previously interpreted as early herded domesticates may instead represent trapped and selectively culled wild individuals in private ownership. In conclusion, we consider whether and why private ownership of free-range animals may quite widely have preceded classic domestic control of goats, sheep and perhaps cattle in southwest Asia.

1. Introduction

The inception of farming is widely recognised as one of the most significant transformations in human (pre)history but the underpinning domestication of crop and especially livestock species has been obscured by disagreement as to the nature of the distinction – in *cultural* terms – between wild and domestic and by the difficulty of recognising such a distinction in the archaeological record. Until a few decades ago, the problem seemed relatively simple (Higgs and Jarman, 1969:32): domesticated plants and animals were those that had been brought under close human control; botanists and zoologists had identified biometric and morphological differences between these domesticates and their suspected wild relatives; and archaeological excavations within the apparent natural ranges of the latter explored when and where ‘domestic’ forms emerged. In the case of the principal southwest Asian ‘farmyard’ animals, on which we focus here, this meant looking for a reduction in body size (beyond that associated with postglacial warming) and changes in the shape or size of horns (sheep, goats and

cattle) and tusks (pigs) (e.g. Hole and Flannery, 1968).

One weakness of this approach is that, depending on the strength of the selective pressures involved, skeletal changes might not become apparent until long after underlying changes in human control (e.g. Jarman, 1976:86; Ducos, 1989; Zeder, 2011:S230; Vigne, 2015:126). The latter may have had a more immediate impact on other lines of zooarchaeological evidence. For example, stable isotope analysis of early postglacial goats and sheep from Anatolia (Neuberger, et al., 2019) and gazelles and goats from the southern Levant (Makarewicz and Tuross, 2012) has detected broadening of diet in animals suspected on other grounds to represent early domesticates. Dietary change does not offer a dependable means of *identifying* domesticates, however, since provision of fodder and/or restriction of movement might in principle lead to either broadening or narrowing of diet.

Alternatively, closer control over gregarious prey species may be detectable more or less immediately in evidence for selective culling, typically focussed on the ‘surplus’ young males targeted for meat in modern domestic herds (e.g. Payne, 1973). This approach to identifying

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early domesticates is also attractive in that selective culling of young males represents a plausible selective mechanism for the skeletal changes observed in southwest Asian sheep, goats, cattle and pigs in the millennia immediately preceding or following their apparent integration into mixed crop/livestock farming regimes (Zohary et al., 1998), although selective hunting of large males may favour similar skeletal changes (Garel et al., 2007). On the other hand, heavy juvenile (or juvenile male) mortality recorded in prehistoric gazelle (e.g. Legge, 1972) and red deer (Jarman, 1971) raised the possibility that close control extended beyond the ancestors of farmyard animals (see below). Moreover, selective slaughter of particular age/sex categories is also documented as an unintended consequence of prey social behaviour (cf. Jarman and Wilkinson, 1972:95; Collier and White, 1976) in modern, non-domestic herd ungulates such as hunted bison (Speth, 2013:178) and reindeer (Ingold, 1980:68) or even fallow deer killed in road accidents (Chaplin, 1969). Despite Zeder's robust defence (2005:141) of mortality data as the 'the optimal method for recognizing the initial stages of goat domestication, and likely the domestication of other primary livestock species (e.g. sheep, pigs, and cattle)', therefore, zooarchaeologists routinely use such evidence to clarify the nature of hunting or herding strategies, but most seem reluctant to distinguish wild from domestic solely on this basis.

These problems of zooarchaeological recognition of domestication are compounded by ambiguities of definition. While most zooarchaeologists agree that domestication of animals involves close human control that constrains their movement, feeding and reproductive activity (e.g. Bökönyi, 1989:22; Clutton-Brock, 1989:7; Arbuckle, 2005:19; Zeder, 2015), this potentially encompasses very diverse human-animal relationships. Even if limited to exploitation for carcass products (as in the 'prey pathway' to domestication – Zeder, 2012), these range today from intensive factory farming to light-touch ranching (e.g. Jarman, 1976:93) and, at the latter extreme, may involve less control than the management of some 'wild' populations for hunting. This diversity of human-animal relationships contrasts sharply with the wild:domestic dichotomy that has widely underpinned zooarchaeological investigation of domestication.

Faced with the diverse forms of management subsumed under the term 'domestic' and the ambiguity of traditional zooarchaeological methods for its recognition, Meadow (1989:87) pragmatically advocates the deployment of multiple lines of evidence, while several recent studies (e.g. Legge and Rowley-Conwy, 2000; Vigne et al., 2011; Stiner et al., 2022a) have persuasively argued for the relevance of particular criteria to the historical/ecological context under investigation. A drawback of this solution is that different criteria may represent different forms or aspects of management, thus obstructing attempts to generalise about domestication.

A radically different and simple solution to the problem of definition is to follow Ducos (1978:54) and Ingold (1986:113) in defining a domestic animal as one that belongs to someone. Although ownership may appear less amenable to zooarchaeological recognition than the elusive 'close human control', we here explore the utility of this approach to elucidating past human-animal relationships in light of recent exploitation in Greece of privately owned groups of feral (or minimally controlled domestic) goats, sheep, cattle and pigs. To this end, we first summarise the results of our ethnographic research in Greece, based primarily on interviews with practitioners and secondarily on visual observations, and then explore possible implications for understanding the hunting-herding transition in southwest Asia. For the sake of clarity, unless otherwise specified, we henceforth use the terms 'domestic' and 'domestication' in their traditional, if rather ambiguous, sense of close human management of animals.

2. Recent exploitation of feral and minimally controlled domestic goats, sheep, cattle and pigs in Greece

2.1. Goats

The well-known *agrínia* of western Crete are phenotypically similar to the wild *Capra aegagrus* and thus thought to represent a long-established feral population (Groves, 1989:50–51). Much less well known but far more widespread in the Greek islands are feral goats that closely resemble, and are often descended from and/or interbred with, local domesticates. While the *agrínia* are 'wild' in the sense that they belong to nobody, the latter feral goats, although behaving like their wild counterparts, are widely regarded as belonging to the herding families from whose control their founding members originally escaped or were released and so are 'domestic' in terms of ownership. The *agrínia* are subject to illegal hunting (Geskos, 2009), but the following paragraphs are concerned with human exploitation of privately owned feral goats, drawing on field observations and interviews (presented in greater detail in Isaakidou and Halstead, 2021; Halstead and Isaakidou, 2024) with herders/hunters on Crete and the smaller southern Greek islands of Kythera, Antikythera and Protí (Fig. 1).

Rights to particular feral goats are typically claimed on the basis of their descent from a domestic herd belonging to the same person or his (rarely her) forebears. Four principal types of evidence are cited (and sometimes acknowledged by others) in support of such claims of ownership: the physical resemblance of feral goats to animals in a neighbouring tame herd; clipping of the ears (in the pattern also applied to the owner's tame goats) of animals that have been trapped and subsequently released; the adherence of adult females and their young to land to which an owner has formal title or customary rights; and, in some cases, the provision of water and perhaps fodder (see below). In recent decades, following widespread abandonment of cultivation and growing scarcity of herding labour, several feral groups were founded by the release of domestic goats (and, occasionally, the purchase and relocation of feral animals), but most originated in unplanned escapes. Escapes too have become more frequent latterly, as increasingly elderly herders give up labour-intensive milking and are less able to pursue errant animals, but even in dairy herds with regular human contact some individual goats may be inclined to escape.

The distinction between domestic (in the conventional sense) and feral goats may be blurred not only by escape/release of the former, but by mating of domestic does with feral bucks, by taming of feral kids for integration into domestic herds (see below), and by provision of water (and, latterly, very modest amounts of fodder) to limit the mobility of feral goats and perhaps also accustom them to human presence. Feral goats are mainly exploited, however, for meat (rather than milk and meat as is usual with their domestic counterparts). To this end, they may be hunted (usually singly or in small numbers and often by poachers) with guns or dogs for more-or-less immediate consumption. Goats are also captured alive, often in much larger numbers, by driving them into a natural or artificial cul-de-sac or by trapping them in an enclosure baited with fresh fodder or especially (at the height of summer) with water (Fig. 2). Driving or trapping may, in favourable circumstances, capture up to several dozen animals per attempt and well in excess of a hundred animals over the course of a year from a local population. Such mass captures are normally subject to selective culling. Typically, does and (perhaps after clipping their ears to mark ownership) all or most female kids are released, as are suckling male kids considered too small for consumption, while older male kids and any remaining male yearlings are retained for slaughter. Those retained for slaughter may also include female kids, if the local population is considered too large, and even adult females if they would be killed by someone else after release, but most adult females are left to die of natural causes.

Because the timing of mating is uncontrolled in feral populations, the birth season tends to be longer than in many domestic herds, with the risk that growth of kids born late (usually to first-time mothers) will be

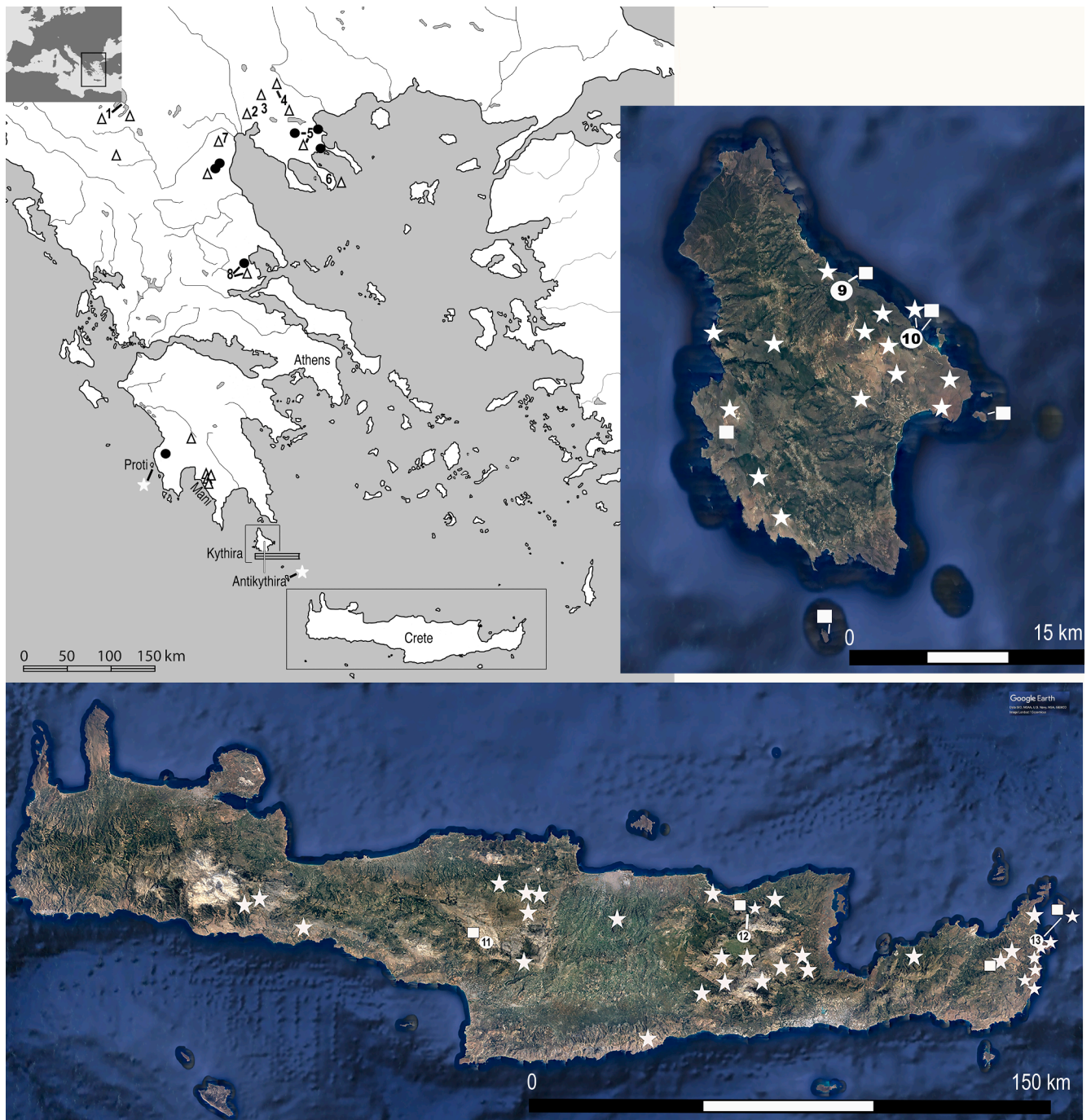


Fig. 1. Map of Greece showing locations of feral and free-range populations discussed in text. Key to symbols: white star = goat, white square = sheep, white triangle = cattle, black circle = pig. Locations named in text: 1 Psarades, 2 Drymos, 3 Assiros, 4 Sevasteia, 5 Varvara, 6 Sykia, 7 Paliambela-Kolindrou, 8 Anavra, 9 Trifyllianika flock, 10 Diakofti, 11 Mt. Psiloritis, 12 Tzermiado, 13 Palaikastro. Locations not named in text shown by symbols alone.

stunted due to the impact of summer drought on pasture. On Crete, we witnessed one attempt to manipulate the timing of mating and hence kidding. An underage and underweight kid was being fed leafy fodder in captivity at the owner's home in the uncertain hope that it would gain sufficient weight to be sold for slaughter. It had been trapped and separated from its first-time mother so she would regain condition in time to be mated together with the other females for the following year.

Culling decisions are also influenced by the context and scale of consumer demand. Contrary to the usual focus on male kids, large and fat-rich adult male carcasses may be sought for certain commensal occasions and occasionally such animals are captured, castrated and released for a few months, until their meat loses its taint, and are then re-

captured when needed. Successful mass captures usually exceed local rural demand and so require coordination with an urban butcher; on Kythira a few decades ago, the larger catches were sent off island, mostly to Athens, but smaller numbers destined for the modest local market might be penned for piecemeal slaughter (Fig. 3). Alternatively, on Crete, the meat or boneless carcasses of *agrimi* used to be stored for varying lengths of time after being salted, smoked, sun-dried, or sautéed and sealed in oil (Plumakis, 2001:34-35, 96; for the Venetian period Papadopoli, 2017:105).

While management of such feral goats is generally very 'hands-off', owners may provide water and a little fodder, usually to accustom animals to visit traps, sometimes to encourage them to stay locally



Fig. 2. Feral goats caught in a trap baited with water, central Crete. The young kid in the background (right) stands at the top of the external stone ramp from which the goats in the foreground have jumped into the trap. Most of the trapped animals were subsequently released. (photo: V. Isaakidou).



Fig. 3. A feral goat kid, retained for slaughter, from the trapped goats in Fig. 2. (photo: V. Isaakidou).

(especially, but not only, in periods of drought), and rarely even to capture them for assessment of their numbers and capacity for sustainable harvesting. Selective culling is directed primarily to achieving an acceptable balance between short-term demand for meat and medium-term maintenance of a sustainable population, but such decisions are also informed – as with herded domesticates – by the desire to improve the practical or aesthetic qualities of breeding animals. Improvement of domestic breeding stock is also one rationale for taming individual feral goats, while some practitioners do so to expand or even establish a domestic herd. Some owners report success in attracting feral individuals to join a domestic herd by providing fodder (traditionally cut leafy branches rather than cultivated hay or grain), while others have found that adults recruited in this way sooner or later leave the domestic pen. The most reliable, but also most labour-intensive, method of taming is reckoned to be the capture and bottle-feeding of new-born kids. On the other hand, provision of fodder (in quantities intended to attract rather than sustain) may suffice to discourage dispersal of feral animals and to accustom them to the proximity of people without active herding or penning.

2.2. Sheep

Most Cretan herders insist that sheep, unlike goats, do not ‘go wild’ because of their greater tendency to ‘flock together’, but some report exceptions. For example, one sheep in a small east Cretan flock above Palaikastro repeatedly escaped from the pen and was earmarked for

imminent slaughter because a second animal was learning to follow its example. Lack of human contact also encourages escapes. A herder on central Cretan Mt. Psiloritis described how a ewe gave birth very late in the season and so was not milked with the rest of his flock but left on the mountain suckling twin lambs; she eventually returned to be milked but the lambs, unaccustomed to him, were wholly unapproachable. Escaped sheep are considered less likely than goats to survive without human intervention, thanks to their reliance on strongly seasonal graze rather than the relatively perennial evergreen browse favoured by goats. They are also less likely to evade recapture because they avoid the inaccessible cliffs and ravines frequented by feral goats. Nonetheless, informants report recent sightings of sheep that, from their unshorn appearance and avoidance of people, were not actively managed, on southwest Kythera and both near Palaikastro (so-called *vetsaropróvata*) and near Tzermiado on Lasithi in eastern Crete. Moreover, the oldest customers in the cafe at Gones on Psiloritis had, as young men, heard accounts of feral sheep that spent summer at around 1800 m near the mountain’s summit and winter around 500 m on its northern slopes until they were wiped out by hunters using the first repeater rifles.

On Kythera from at least the early 20th century, some sheep were managed in a manner not dissimilar to that described above for feral goats. During the 1930s, several residents of the inland village of Aro-niadika took advantage of the contraction of cultivation (a result of mass emigration) to keep a few sheep, 10–15 per household and altogether a hundred or more, at the coastal hamlet of Diakofti. The sheep were provided with water in summer, but otherwise fended for themselves, roaming freely on the surrounding slopes except where walls protected the few remaining cultivated plots (Fig. 4). Their owners occasionally turned them back if they strayed far enough inland to threaten crops, but otherwise they were neither herded nor enclosed. They were not milked, but twice a year their owners collectively rounded them up or cornered them in the cave where they rested at midday: first in spring to select lambs 4–5 months old for slaughter in the urban market of Athens and to clip the ears of the (mostly female) lambs left for breeding; and secondly in June for shearing. This arrangement came to an end by 1950, as the elderly owners of the sheep died off, although it was briefly resumed in the 1960s by two of their descendants who also owned feral goats occupying rougher terrain. Again in the early 20th century, slopes immediately south of Diakofti were grazed by sheep with multiple owners from the village of Mitata. These animals too were left largely undisturbed, but were restricted to a pair of large enclosures, each of which was grazed and manured in alternate years and sown in the intervening years.

A few kilometres to the north during the 1960s, a resident of Tri-lyllianika built up a flock of up to 70–80 sheep, again exploited for their lambs (and wool) but not milked. These sheep too ranged freely over uncultivated land but were occasionally provided with a donkey-load of hay ‘so they did not forget us’. On seeing the donkey and hearing the



Fig. 4. The slopes above Diakofti on the northeast coast of Kythera were home to free-ranging sheep in the mid-20th century, following the abandonment of cultivation and rearing of hobbled livestock in the stone enclosures that are still visible. (photo: V. Isaakidou).

shouts of the man that accompanied it, the sheep would approach and twice a year were rounded up in an out-field pen and smeared with used engine oil to discourage the ticks that could otherwise weaken them severely. On a third occasion, in spring, the sheep might be trapped in a cave near the coast for loading onto a boat or else the donkey and a borrowed tame ewe led them to a pen in the home village. The captive sheep were shorn and then lambs 4–5 months old (most males and some females) and any barren yearling females were selected for despatch to Athens, while the breeding adults were released and ultimately left to die of old age.

Both the Diakofti and Trifyllianika sheep lived free-range over many ovine generations. A further Kytheran example of shorter-term light-touch management concerns lambs raised on various offshore islets, for which grazing rights were auctioned each year by the island municipality to one of the butchers supplying carcasses to Athens. In winter, the successful bidder bought up lambs from multiple owners on Kythera and its smaller neighbour Antikythera and, after selecting the older and heavier ones for immediate slaughter, transferred their younger and under-weight counterparts by boat to the offshore islets. In April or May, he and a few helpers rounded up the lambs, sometimes using tame ewes to lead them into a natural bottleneck near the landing point for the boat.

2.3. Cattle

In the 1970s and 1980s, residents of hill villages on the western side of the mountainous Mani peninsula (Fig. 5) of the southern Greek mainland found that cattle of the local rustic breed were causing serious damage to their gardens, fields and hay meadows. These cattle, previously herded on the upper slopes on both sides of the Mani watershed, had been abandoned or left to range freely by their elderly owners and were literally out of control, with the free-born young especially unapproachable. The animals were unambiguously feral and initial attempts to limit their numbers and offset the damage they caused largely involved hunting: they were shot where they were encountered, far from any road, and butchered on the spot, with the most valuable carcass parts then carried on hunters' backs to where they could be loaded into baskets for onward transport by horses or donkeys down to the village. The villagers, unaccustomed to eating beef, were initially unenthusiastic customers. Over the following years, a few local farmers established legal title to the cattle and began to exploit them for meat more systematically, providing water and hay to attract them to more accessible parts of the landscape and building stone-walled pens which they baited with hay to trap the animals. They would leave the iron gate of the pen open for two or three days until enough cattle (perhaps 25–30 head, according to one practitioner) were corralled, although at first the larger animals escaped until narrower pens were built (a strategy also used with feral goats) to prevent them from achieving sufficient momentum to jump over the gate. Of the captured animals, those of a suitable size



Fig. 5. The higher western slopes of Mt. Taygetos in the Mani peninsula of southern mainland Greece, where feral cattle spread in the last decades of the 20th century. (photo: V. Isaakidou).

(mainly males 2–5 years old) were despatched to the urban slaughterhouse and a few that were too small were retained and fed to achieve the desired weight, while adult cows and many younger females were released as breeding stock. In subsequent decades, to capitalise on market demand for heavy but young carcasses, some owners have crossed the original rustic stock with specialised beef breeds and stall-feed the young animals destined for slaughter, but leave the breeding females largely free-range with fodder provided only sparingly to maintain familiarity with the herder.

Cattle, especially of unimproved breeds, were also recently quite widely managed for meat with limited human intervention in the hills of central and northern Greece. For example, in the 1960s and 1970s around Sykia at the southern end of the Chalkidike peninsula, cattle of the small local rustic breed (Fig. 6; Kugler, 2010:31) came down in summer to stubble and fallow fields near the sea, but spent most of the year browsing and grazing on adjacent low hills with occasional provision of straw or hay to discourage dispersal. In the north of the peninsula, in the oak and beech woods around Varvara, similar rustic cattle browsed under the oversight of a herdsman until cultivation was abandoned locally, after which the cattle were left unsupervised year-round in the woods. Most of these cattle were not very tame and the calves had to be lassooed for delivery to the butcher. Around the same time, at Anavra on the inland mid-slopes of Mt. Othrys in Thessaly, an informant stall-fed a few local rustic cattle over winter but in summer let them range freely, with weekly visits, on high ground. At pasture, the cows were accompanied by their young calves and informants in both Sykia and Anavra recall how one of the cows stayed near the latter 'on guard' (cf. Schloeth, 1961:577; Lazo, 1992:62–63; Boissou et al., 2001:119) while the others grazed further away. If a threat was detected, the cows formed a defensive ring around the calves, although wolves did take a few animals. Despite their relative self-sufficiency, the cattle did not move far from the area in which they were released and were rounded up without undue difficulty. At Sykia, Varvara and Anavra alike, the cattle were reared primarily for the meat of their calves, but a few Sykia cows were used for ploughing, as were some cows and castrated oxen at Varvara. Some of the tamer Anavra cows could be milked while stalled, but not outdoors. At Varvara too most of the cows were rather intractable, but a few (those with the biggest udders and biggest calves and thus best milk supply) were tamed with cut branches of fresh browse and could then be milked for household needs.

The dwarf cattle around the Prespes lakes (Kugler, 2010:26) in the far northwest of the country were until the 1970s thoroughly domestic: reared in small numbers for milk and the meat of their calves and, in some villages, also used for ploughing. At Psarades on the shores of



Fig. 6. Cattle of the rustic Sykia breed in open woodland near Sevasteia, Sokhos, Central Macedonia. (photo: P. Halstead).

Great Prespa Lake, the cattle were stalled over winter in the basements of their owners' houses (Fig. 7) and by day grazed in a combined village herd, watched over in turns by the owners. Then, following a ban on stalling livestock within the village and abandonment of the vineyards, protection of which had previously required close supervision of the grazing herd, the cattle were left to range freely – mainly on the margins of the lake (Fig. 8). Most of these cattle now fend for themselves, resulting in losses to wolves and to starvation over winter. The few dozen adult bulls and some of the far more numerous adult cows can be aggressive, but at least one cow is regularly given bran and salt to keep her friendly and she is milked for one-two months after giving birth, until the calf is big enough to make this difficult. Young calves are fitted with ear-tags, if possible, but do not recognize their owners and, if selected for (household/local) consumption, are shot at something like one year of age. As the composition of the local population makes clear, most male calves are slaughtered for consumption and many/most young females are spared as breeding stock, while most adult cattle are left to die of natural causes.

A final example relates to individual animals sacrificed to village saints at *kourbáni* festivals, once widespread across Greece (Georgoudi, 1989). The sacrificial victims might be purchased by collective subscription or provided as offerings by owners of livestock. In the early 20th century at the neighbouring north Greek villages of Assiros and Drymos, a young male calf was regularly offered to the saint and allowed to graze freely in the village fields and gardens before being slaughtered for the *kourbáni*. Thanks to this privileged diet, the calf grew into a sizeable bull in the intervening one-two years, during which he accompanied the combined herd of village cattle out to pasture each day and mated any receptive cows. Largely lacking human contact, some of these bulls were aggressive to farmers whom they encountered in the fields. In the much smaller north Greek community of Paliambela-Kolindrou, again in the 1920s or 1930s, a bull calf was on one occasion given to the church and again roamed the fields and serviced the village cows, but enjoyed this lifestyle until 5–6 years of age. In winter he was regularly fed at the houses that he visited in search of receptive cows and was of a good-natured disposition.

2.4. Pigs

Pigs too have been widely reared under more or less extensive management, especially in hilly parts of the Greek mainland (Halstead and Isaakidou, 2011). In areas still under cultivation, groups of traditional long-legged pigs ranged over stubble and fallow fields and patches of woodland under the continuous oversight of a herder, much like the sheep and goats with which they typically shared such landscapes. For example, among the acorn- and beechmast-rich woodlands around



Fig. 7. Recently abandoned house in village of Psarades, Great Prespa Lake, northwest Greece, with first-floor living accommodation over ground-floor byre and barn. (photo: V. Isaakidou).

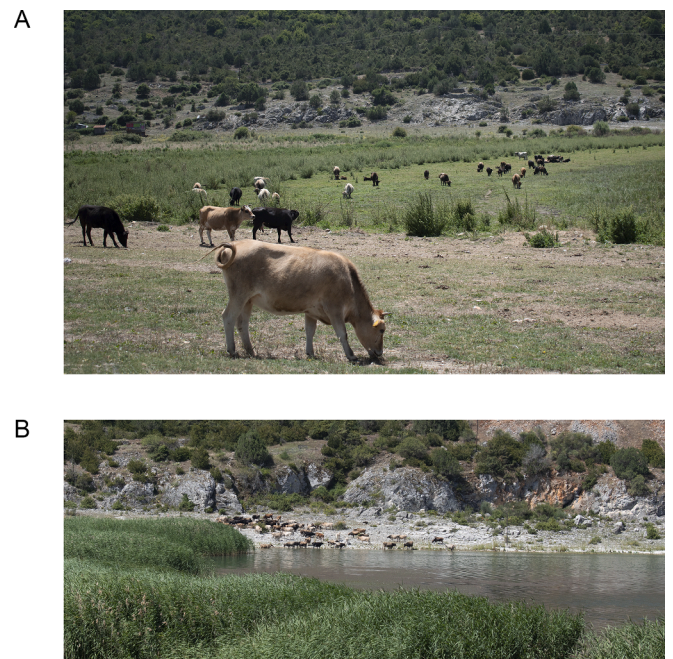


Fig. 8. Dwarf cattle at Psarades, Great Prespa Lake, northwest Greece: (a) grazing around the lake; and (b) drinking water at the lake edge. (photo: V. Isaakidou).

Varvara in the northern Chalkidike peninsula, pigs (like the small local cattle) were herded until cultivation locally was abandoned, when they were left to forage freely, albeit provided with some fodder (see below), farrowing huts and shelters for growing piglets (Fig. 9). Likewise, until the 1970s at Thessalian Anavra, pigs of unimproved domestic breed were housed but otherwise left to forage year-round outdoors, where

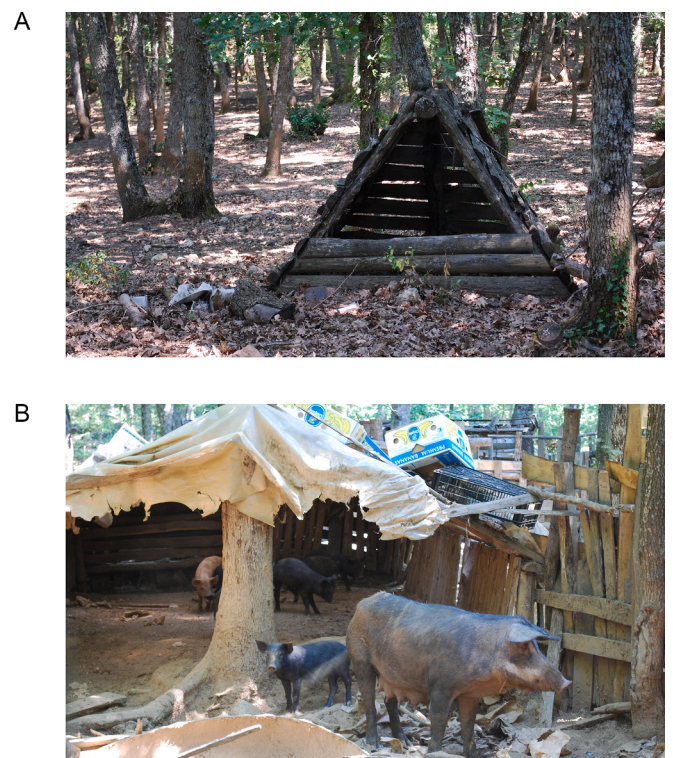


Fig. 9. Woodland with free-range pigs near Varvara, Chalkidiki peninsula, northern Greece: (a) farrowing hut; and (b) shelter for sow and growing piglets. (photo: V. Isaakidou).

they suffered some losses to wolves but did not run off (wild boar were unknown locally). Today, free-range pigs in mainland Greece have widely interbred with wild boar, some by human design (the resulting lean, gamey meat commands a higher price) and others because domestic sows are attracted to increasingly widespread wild males. Apart from the odd individual carrying a bell, some of their offspring closely resemble their wild relatives (Fig. 10) and are shot as such by undiscerning urban hunters. The free-range pigs, whether of traditional breed or cross-bred with wild boar, tend to grow slowly and their young are generally slaughtered at one to two years of age when they achieve a similar weight to stall-fed animals of improved domestic breeds culled after just a few months. Although largely subsisting by foraging, they may regularly be given very small amounts of grain (Halstead and Isaakidou, 2011:163 fig. 16.3-4) to 'keep them sweet', thus making them easier to locate and round up and discouraging them from running off with wild boar.

2.5. Synthesis: Ownership and selective culling of feral and minimally controlled goats, sheep, cattle and pigs

The overwhelming majority of goats, sheep, cattle and pigs in Greece today are managed under a degree of close human control that would unambiguously meet zooarchaeologists' traditional criteria for domestication. A few individuals of all four species, however, escape or are released/abandoned from close management and form long- or short-lived feral populations: on the mainland, especially of cattle and pigs, thanks to their ability to defend themselves against predators; and in the largely predator-free islands, especially of goats, thanks to their preference for inaccessible terrain, but also to a limited extent of sheep. Consequently, all four species exhibit a more or less continuous spectrum of management intensity from close control over mobility, diet and reproduction through occasional provision of shelter, fodder/water or protection from predators/parasites, to a free-range existence where human interference is limited to periodic culling. In all four species, there is also movement across this spectrum, especially by animals escaping or released from close control, but also by free-ranging individuals recruited into domestic management. When fodder is provided to free-range animals, very modest quantities may be effective in discouraging them from dispersing or in attracting them to traps. Even at the minimal-control end of this spectrum, many (probably most) of the animals culled are considered private property.

Proprietorial claims are rooted primarily in ownership of the domestic herd from which animals originally escaped or were released, but may be reinforced by marks of ownership (ear clipping), location on land to which the claimant has rights, or provision of shelter, water or

fodder. The objects of these claims are domestic in the terminology of Ducos and Ingold. The owners of such animals (in common with regular hunters of particular species – e.g. Loukopoulos, 1930:184-7) often describe their feeding and social behaviour in terms strikingly mirroring academic accounts of their wild or feral conspecifics. Based on personal observation or lore handed down by their elders, this knowledge provides much of the expertise required to tame such animals and maintain them under controlled management.

As with herds under conventionally domestic management, owners of feral or minimally controlled goats, sheep and cattle typically practise selective slaughter of young males, surplus to herd renewal, and preferentially spare females. Most practitioners rationalise this selectivity in terms akin to 'deferred harvest' (cf. Alvard and Kuznar, 2001) rather than conservation *per se*, a point highlighted where owners deviate from selective or delayed slaughter because they fear that any animal spared would be killed by others. The proportion of young female ruminants spared varies in accordance with the owner's desire to expand or limit the local population, but the high birth-rate of pigs makes most young females of this species surplus to reproductive requirements and, at Anavra, most female as well as male pigs were neutered before sexual maturity and reared for slaughter. Perhaps unsurprisingly, owners of free-ranging feral/minimally managed goats, sheep and cattle normally leave elderly females at the end of their breeding life to die at pasture of natural causes. In more closely managed herds such deaths may also occur, especially in bad weather, but retired breeding females, both in Greece and further afield, are routinely allowed to gain weight for a few months in preparation for consumption 'so they do not go to waste', as one Greek informant put it. Once fattened, depending on the size of the herd and how many are culled, they are either sold (typically in large numbers) to commercial butchers or slaughtered (in small numbers) and perhaps preserved (e.g. as salted mutton, potted beef, etc.) for household consumption (e.g. Payne, 1973:301; Koster, 1977:234-5; Hesse, 1984:250; Black-Michaud, 1986:46; Martínez, 1991:206; authors' field notes from Cyprus, Greece, Spain, Turkey). The implications of the contrasting treatment of elderly females between feral and closely managed herds are considered below.

The selective culling of young males by owners of feral or minimally controlled, but privately owned, goats, cattle and sheep in Greece is consistent with evidence from various parts of the world that deferred harvest of game and conservationist behaviour are rare among hunter-gatherers (e.g. Ingold, 1980:68-69; Alvard, 1995; Hames, 2007; also Peacock, 1998). Alvard and Kuznar (2001:295) argue that deferred harvest is 'only likely to occur when prey are highly valued, private goods', in line with Woodburn's listing (1982:433) of selectively culled wild herds and other wild products 'improved or increased by human labour' among the valued assets over which 'delayed-return' hunter-gatherers, as he characterises them, typically hold rights (also Rowley-Conwy et al., 2012:27). Conversely, among 'immediate-return' hunter-gatherers, a generalised right to 'the ungarnered resources of their country' (Woodburn, 1982:437) represents a powerful disincentive to deferring consumption of game.

In the following section, we use our ethnographic data from Greece to explore whether zooarchaeological evidence for selective culling of young males of medium- to large-sized social ungulates in late-glacial and early-postglacial southwest Asia can more plausibly and fruitfully be interpreted in terms of close control (domestic management) or deferred consumption and 'ownership'. In doing so, we must also consider whether apparently selective culling might be an unintended consequence of the social behaviour of the prey species. In common with other herd-living ungulates, the wild or feral relatives of domestic goats, sheep, cattle and pigs tend to seasonal segregation of males from adult females and their young. Young male goats, sheep and cattle tend to leave the maternal group when they are large enough to begin to dominate adult females (e.g. Schloeth, 1961:601; Shackleton and Shank, 1984:503) and rather sooner in pigs, among which conflict between mature males is more violent (Frädrich, 1974:135-136). In practice,



Fig. 10. Free-range pigs, that have interbred with wild boar, in woodland near Varvara, Chalkidiki peninsula, northern Greece. (photo: V. Isaakidou).

young male goats (Husband and Davis, 1984:419; Edge and Olson-Edge, 1990; Nicholson and Husband, 1992:137), sheep (Grubb and Jewell, 1966:205, 209; Grubb, 1974:459; Bon and Campana, 1989:73-74; Bon et al., 1991:94; Le Pendu et al., 1996:211) and pigs (Frädrich, 1974) separate from the female group when their mothers next give birth and thus at around one year of age or, in some cases, from the preceding rutting season and thus from the middle of their first year, while young male cattle segregate a little later at 1.5–2 years (Daycard, 1990:50; Bouissou et al., 2001:120). Newly separated young males are particularly vulnerable to hunting, non-human predation and other sources of natural mortality (e.g. Chaplin, 1969; Grubb and Jewell, 1966:200; Edge and Olson-Edge, 1990; Legge and Rowley-Conwy, 1988; Rowley-Conwy et al., 2012:25).

To summarise the implications of recent exploitation of feral ungulates in Greece for interpretation of zooarchaeological mortality data, we note the following:

- ‘Selective’ slaughter of yearling or older male goats and sheep and of slightly older male cattle may be an unintended consequence, shaped by prey social behaviour, of human hunting of free-living wild populations rather than a deliberate outcome of the management of controlled domestic herds.
- Sexually biased mortality among (early) first-year goats and sheep or among first- or (early) second-year cattle, that is of animals still accompanying their mothers, should represent intentionally selective culling by human agents and would thus imply private ownership but not necessarily controlled domestic management.
- On-site evidence for deaths of breeding adult females is more likely in controlled domestic herds, in which such individuals tend to be fattened for consumption, than in privately owned but uncontrolled groups, in which ‘retired’ breeding females are typically left to die in the wild.
- In pigs, because of their much larger number of offspring, intentionally selective culling of young males (and sparing of adult females) is likely to be less marked than in goats, sheep or cattle (also Rowley-Conwy et al., 2012:25).

3. Selective culling and ‘ownership’ of gregarious ungulates in late glacial-early postglacial southwest Asia

Zooarchaeological evidence from southwest Asia suggests that Upper Palaeolithic exploitation of herd ungulates, despite the vulnerability of juvenile and elderly individuals, focussed on prime adults (Stiner, 1990:330 fig. 9; Atici, 2009; Marom and Bar-Oz, 2013). Such selective killing of the largest and least vulnerable prey, perhaps partly reflecting the need for fat-rich carcasses in harsh glacial-maximum conditions (Stiner, 1990:336; but cf. Driver and Maxwell, 2013), is more consistent with stalking or ambushing of individuals than driving or trapping of herds (Koike and Ohtaishi, 1987:265; Ingold, 1980:68-69; Myserud, 2011:829 table 2; Atici, 2009:15; but cf. Stiner, 1990:317).

Conversely, many Epipalaeolithic and Neolithic assemblages exhibit high proportions of young ungulates: especially of gazelles, giving way over time to goats and/or sheep, in the lowlands of the Levant; and of more diverse species, often including sheep and/or goats from an early date, in the Taurus-Zagros highlands of southern Turkey, northern Iraq and western Iran (e.g. Peters et al., 1999:35 fig. 5; 2014:140–141 figs. 2-3; Zeder, 2005:142 table 4; Conolly et al., 2011; Bar-Oz et al., 2013; Martin and Edwards, 2013:60 fig. 4.3). At several Epipalaeolithic and Pre-Pottery Neolithic (‘PPN’) sites in the southern Levant, gazelles exhibit frequencies of immature deaths that, in sheep and goats, have been cited as evidence of domestic management (Legge, 1972). Limited sexual dimorphism (e.g. Munro et al., 2011) obscures whether male juveniles were selectively targeted (e.g. Davis, 1983; Bar-Oz et al., 2004; Sapir-Hen et al., 2009), while exploitation probably varied given the presence of three gazelle species in diverse habitats (Martin, 2000). In any case, gazelles (and fallow and red deer, less widespread but

sometimes exhibiting high juvenile mortality) are arguably ill-suited to the close confinement or controlled movement of domestic herds because their adult males are seasonally territorial, rather than hierarchical as with goats, sheep, cattle and pigs (Garrard, 1984; Martin, 2000:23-24).

Some analysts have instead attributed early examples of heavy juvenile mortality to modes of exploitation distinct from both earlier hunting and later domestic herding (Peters et al., 2005:110): e.g. ‘controlled predation’ and ‘herd following’ (Jarman, 1976:93); ‘specialised hunting’ (Bökönyi, 1989:23); ‘proto-élevage’ (Ducos, 1993:164); ‘control in the wild’ (Vigne et al., 2011:S256); ‘female breeding’ (Redding and Rosenberg, 1998); ‘male sink’ hunting and short-term corralling (Redding, 2005:44-46); and ‘intensified hunting’ (Munro, 2009:142). These models are articulated in varying levels of detail, but Jarman’s ‘herd following’ implies something akin to ownership of prey, while his ‘controlled predation’ and Redding’s short-term corralling both involve drives or traps, as in the recent Greek examples. Conversely, Redding’s ‘male sink’ hunting (of sheep) targeted young adult males that were older and ranged more widely than the juvenile males associated with maternal herds on which recent Greek exploitation of feral goats and minimally managed sheep focussed.

Drawing on our Greek examples, we next consider the interpretation of ungulate mortality in early postglacial southwest Asia, focussing initially on three sites: Ganj Dareh in the Zagros highlands of western Iran (goats); Abu Hureyra in the Euphrates plain of northern Syria (gazelles, goats and sheep); and Aşıklı Höyük on the central Anatolian plateau of southern Turkey (sheep and goats).

3.1. Ganj Dareh

Palaeolithic occupants of the Zagros highlands pursued what are generally accepted as wild goats, preferentially hunting adult males (Hesse, 1982:404 fig. 1; Zeder, 2005:134 fig. 4) in line with the usual focus on prime adults, exercised as late as the 10th millennium BCE at Tepe Asiab and Zawi Chemi (Daly et al., 2021:fig. S7). By contrast, goats from Aceramic Neolithic Ganj Dareh (early 8th millennium BCE) at 1400 m in the uplands and Ali Kosh (mid-7th millennium BCE) further south in the lowlands have been widely discussed as possible early domesticates and exhibit selective culling of young males. While the Ali Kosh goats have been considered domestic on biogeographical grounds, because they fall outside the natural range of wild goats, this is not so for upland Ganj Dareh (but see Daly et al., 2021). Here domestic status had been claimed on the basis of smaller body size than in earlier Zagros assemblages, but Zeder (2001; 2005) showed that this is an artefact of the reduced representation of large adult males.

Hesse and Zeder (Hesse, 1984; Zeder and Hesse, 2000; Zeder, 2001; 2005; 2008) focussed instead on demographic structure, combining epiphyseal fusion evidence for age at death with biometric evidence for sex to develop sex-specific mortality profiles for the Ganj Dareh goats. Breadth or depth measurements for fused specimens of anatomical parts that achieve epiphyseal closure from the late first (e.g. distal humerus) to late third-fourth (e.g. distal radius) years of life (fusion ages after Zeder, 2006:107, fig. 15) are, with increasing age, skewed progressively leftwards towards small (presumably female) individuals. The authors saw this apparent emphasis on culling young males and adult females as more closely matching pastoral than hunting decision making (Hesse, 1984:261) and as representing ‘a managed, and, therefore, domesticated population’ (Zeder, 2001:76).

As to what ‘domesticated’ meant in this context, although Hesse (1984:244-245) emphasized the value that herders assign to *accumulation of livestock* (as opposed to hunters’ emphasis on *sharing of carcasses*), he concluded that mortality data inform on herding rather than ownership (1982:414 n1). In a similar vein, Zeder saw the ‘manipulation of herd demographics ... in a manner consistent with ... herd propagation’ as ‘the central feature of domestication’ (2005:141) and, in describing the Ganj Dareh goats as ‘herded’ (2005:139), apparently

emphasised management over ownership. Moreover, whereas Hesse (1984:256-258) attributed a relatively small faunal sample (Hesse, 1982:412 table 2) from the earliest level E (containing more adult females and newborn kids than the rest of the Aceramic assemblage) to hunting of nursery herds of mothers with young, Zeder (2005:137) rejected sexually biased culling as an outcome of hunting. Zeder mainly focussed on the combined assemblage from all Aceramic levels which indicates much heavier mortality among males than females in the second and subsequent years (Zeder, 2008:251 table 1). Studies of wild goats, however, and of feral animals in Greece, demonstrate that this pattern is compatible with hunting of wild bachelors after separation from their mothers and so does not, in isolation, identify the Ganj Dareh animals as domestic in terms of either management or ownership (also Hesse, 1984:251).

The pattern of mortality identified by Hesse and Zeder also warrants further analysis, considering in turn the evidence for deaths of first-year kids and adult females. First, among fused distal humeri of Ganj Dareh goats, depth measurements (Dd) display a clearly bimodal distribution with smaller specimens to the left outnumbering larger ones to the right (Fig. 11, after Zeder, 2001:70 fig. 7c). Accepting Zeder's proposed metrical cut-off between the sexes (29.88 mm – Zeder, 2001, 71 table 4), which is informed by biometric data for modern wild goats in the same region, this would represent approximately 2 females:1 male among goats that survived beyond the latter first year and were discarded on site. This in turn, assuming an even sex ratio at birth, implies a large number of 'missing' males that either were killed in their first year and thus excluded from the measurable fused specimens (Zeder, 2001:74) or died/were discarded elsewhere. In fact, as Zeder notes, young specimens found on site but identifiable only to generic *sheep/goat* indicate substantial first-year mortality (35 % – presumably an underestimate given biases of bone survival and retrieval) and most of these specimens are presumably from goats, which heavily outnumber sheep among speciated material (Zeder, 2001:73). Moreover, among first-year deaths identifiable to goats, the few measurements of unfused and fusing distal humeri (Zeder, 2001:70 fig. 7c) are not concentrated at the lower end of the range for fused Dd, as expected if they represented young females,

but are scattered widely among the fused specimens (Fig. 11) and so again indicate preferential slaughter of young males (Zeder, 2001:74). While a sexually balanced cull of first-year kids cannot be excluded categorically, it would require selective slaughter of females at a younger age than their male counterparts, such that they were not preserved in a measurable state, but this is demographically implausible. In semi-arid environments, the birth and death rates of wild (e.g. Edge and Olson-Edge, 1990), feral (Husband and Davis, 1984) and extensively managed domestic (e.g. Koster, 1977:237-9; Cribb, 1991:28-29) goats may vary greatly from year to year. Accordingly, owners of both feral goats in Greece and extensively managed domestic herds more widely usually retain most first-year female kids as potential replacement breeding stock, while in a wild population, given the tendency for groups of related females to range less widely than males (e.g. Edge and Olson-Edge, 1990), hunters cannot rely on the prompt replacement of slaughtered dams by immigration from neighbouring areas. Whether the Ganj Dareh goats were free-range/wild or herded/domestic, therefore, selective slaughter of female kids would represent an extremely unstable strategy of management that is incompatible with zooarchaeological evidence of relatively constant taxonomic and demographic composition, implying sustainable exploitation, through several phases of rebuilding (Hesse, 1984:250 table 2; Daly et al., 2021:fig. 2a). Instead, the heavy cull of first-year kids was surely focussed primarily on males, as Zeder proposed.

Secondly, combined epiphyseal fusion and biometric data for specimens identified to goat imply that 60 % of females died as young adults in their third year (Zeder, 2001:73 fig. 9a) and so had probably given birth at most once. Indeed, in recent domestic herds such young dams tend to be culled precisely because they have failed to produce or rear a healthy kid (e.g., Redding, 1981:74), while similar selectivity – with the same rationale – is documented for recent minimally managed sheep in Greece (above, 2.2). With a further 25 % of female goats at Ganj Dareh apparently dying before their third year, only 15 % of females (fewer if some first-year 'sheep/goat' remains represent female kids) would have survived into mature adulthood (Zeder, 2001:73 fig. 9a). By comparison, in idealised mortality models for domestic sheep and goat herds

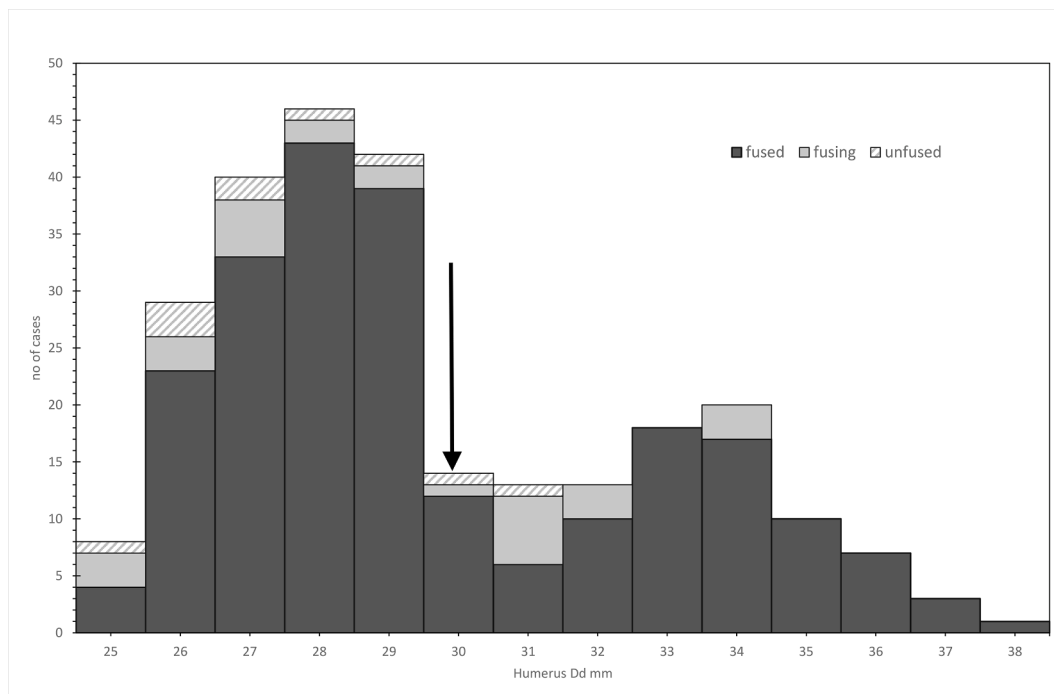


Fig. 11. Distribution of distal humerus depth measurements (Dd) of Ganj Dareh goats (after Zeder, 2001:70 fig. 7c). Key: dark fill = fused specimens, light fill = fusing specimens, hatched fill = unfused specimens; arrow marks suggested cut-off between female specimens to left and male specimens to right (after Zeder, 2001:71 table 4).

managed for meat and/or milk, 25 % (Redding, 1981:203 fig. x-19) or even 55–60 % (Payne, 1973:282–283 figs. 1–2) of females survive beyond their third year, with the higher figures strongly favoured by anecdotal accounts from recent herders of extensively managed domestic goats in Greece. The inferred 15 % of mature adult females at Ganj Dareh could only have sustained both a viable local population and heavy human predation if we make wholly unrealistic assumptions regarding their longevity and fertility: for example, that each of these does survived to the end of her eighth year and, from her second year onwards, produced two surviving offspring annually. In practice, although goats produce twins more often than sheep, a realistic average kidding rate in extensively managed animals may be 1.2 kids per doe per year (Redding, 1981:68, 70), while from their sixth year natural deaths among these breeding females tend to increase (Redding, 1981:75).

The strong under-representation of adult female goats at Ganj Dareh implies that many/most such breeding animals ultimately died away from the site. In recent managed herds of domestic goats, elderly females were normally consumed at the end of their productive life, often after a brief period of fattening. In recent Mediterranean and Near Eastern villages, ‘retired’ does from small household herds were often destined for domestic consumption, fresh or preserved, while those from large herds geared to production for the market were typically sold to urban butchers. Despatch to urban markets can be ruled out for the Aceramic Neolithic, however, and the elderly females ‘missing’ from Ganj Dareh more likely died off-site from natural causes, as did their counterparts among privately-owned feral goats, feral cattle and minimally managed sheep in modern Greece that were normally left to die ‘in the wild’. In this respect, the demographic structure of the Aceramic Ganj Dareh goats is more compatible with the exploitation of wild (i.e. free-range) animals than of conventional domestic *management*.

If we accept this argument, the heavy cull of first-year kids would have involved the pursuit of wild nursery herds comprising adult females with kids of both sexes (as previously suggested for the earliest Level E – Hesse, 1984:258) and probably also subadult yearling females (e.g. Macar and Gürkan, 2009). From these herds, the Ganj Dareh mortality data indicate that killing of adult and yearling females was avoided, while the same has been argued here indirectly for female kids. The implied selective culling of male kids would have been a deliberate choice, rather than an unintended consequence of goat social behaviour, and would thus imply deferred consumption of animals that were domestic at least in the sense of belonging to the site’s occupants. As for the method of selective culling, adult females could probably be avoided as targets during stalking or ambushing of nursery herds, but arguably not so female kids given the difficulty of distinguishing them from male kids at a distance (e.g. Ducos, 1993:164; Gundogdu and Ogurlu, 2009; Macar and Gürkan, 2009). This implies that these herds were captured alive *en masse*, by driving or trapping, and (most) dams and female kids and female yearlings were then released while (most) male kids were selected for slaughter.

The presence of perinatal bones of sheep/goats, shed deciduous teeth of goats, and dung from herbivores has also recently been cited as evidence that the Ganj Dareh goats were penned on site and thus under domestic management (Yeomans et al., 2023). In the recent Greek cases outlined above, however, captured feral goats and minimally managed sheep were often made to walk to where they would be consumed and were sometimes corralled there to await piecemeal slaughter. The dung at Ganj Dareh may thus be attributable to temporary corraling and/or slaughter and gutting on site of captive ‘wild’ animals. The deciduous teeth with eroded roots could likewise have been shed pre- or post-mortem from animals in their late second year that were briefly held and then perhaps slaughtered on site, while perinatal remains could represent abortions and infant deaths in a captive nursery herd undergoing stressful selection for release (and, perhaps, earmarking) or slaughter. Moreover, foetal feral kids are today sometimes discarded ‘on site’, when the owner has killed a female yearling wrongly believed not to be pregnant. On present evidence, therefore, we regard the goats from

Aceramic Ganj Dareh as ‘domestic’ in terms of ownership, but not demonstrably ‘domestic’ (and arguably not so) in terms of management.

3.2. Abu Hureyra

At Epipalaeolithic (12th–10th millennia BCE) and PPN (9th–7th millennia BCE) Abu Hureyra in lowland northern Syria, evidence of highly seasonal slaughter of Persian gazelle (*Gazella subgutturosa*) is compatible with interception of the animals during their annual migrations (Legge and Rowley-Conwy, 2000:435–439, 452–453). The full range of ages represented suggests non-selective killing of entire herds by driving (Legge and Rowley-Conwy, 1987; 2000:449). There is no evidence of significant control over the movement, feeding or reproductive activity of these gazelles and thus no indication of their domestication in the conventional sense. Equally, the proposed slaughter of entire herds, including both sexes (Legge and Rowley-Conwy, 2000:447), represents the opposite of the sustainable culling typical of livestock under private ownership, while migratory animals pose obvious practical impediments to enjoyment of deferred harvest.

Sheep were sparsely present at Epipalaeolithic Abu Hureyra and, although modest evidence of herbivore dung has tentatively been attributed to on-site penning of wild sheep (Smith et al., 2022), derivation from on-site slaughter of this or other species is not impossible. In the PPN, goats too appeared, after which sheep and goats together progressively surpassed gazelles (Legge and Rowley-Conwy, 2000:461–3). Both sheep and goats were killed year-round and so lived locally rather than migrating through the area (Legge and Rowley-Conwy, 2000:462 fig. 13.19). Since the PPN settlement was considerably larger than its Epipalaeolithic predecessor, a decline in frequency of other non-migratory species arguably resulted from over-hunting, with sheep and goats bucking this trend because they were under domestic management (Legge and Rowley-Conwy, 2000:462–3).

PPN biometric evidence suggests that, among adults of both these species, smaller females outnumbered larger males (Legge and Rowley-Conwy, 2000:466 figs. 13.23–24) and thus that young males were preferentially culled, although this is clearer for the more sexually dimorphic goat. The scarcity of large male goats is again evident in measurements of fused body parts representing animals surviving beyond the latter first and subsequent years (Legge and Rowley-Conwy, 2000:467–468 figs. 13.25–26). Because bones fusing in the first year continue to grow thereafter (also Popkin et al., 2012, 1780), Legge and Rowley-Conwy (2000:467) cautiously suggested heavier male mortality mainly from the second year onwards, by which age seasonal sexual segregation is likely in wild or free-range goats. Without data on the scale and sexual breakdown of first-year mortality, no case can at present be made for or against deferred harvest and the ownership status of these goats, although this is perhaps academic given the authors’ persuasive argument for domestic management of both sheep and goat.

3.3. Aşıklı Höyük

Located at ca. 1100 m on the central Anatolian plateau, Aşıklı Höyük is an Aceramic Neolithic settlement with occupation spanning the early 9th–early 8th millennia BCE. Sheep (mainly) and goats increase from a minority faunal component in the lowest levels to heavy predominance in the uppermost (Stiner et al., 2022a:figs. S1–S2). The site lies broadly within the suspected natural distributions of wild sheep and goats, local domestication of which during the Aceramic Neolithic has been argued on zooarchaeological (mainly demographic) and contextual evidence (Stiner et al., 2014; 2022a).

Accumulated dung suggests on-site penning of animals (Mentzer, 2018:120–122; Abell et al., 2019) that, judging by associated phytolith evidence for mainly grazed but also browsed diet (Tsartsidou, 2018:166), potentially included both sheep and goats, while remains of foetal and neonatal sheep/goats (not identified to species) have been attributed to abortions and perinatal deaths among penned mothers and

infants (Pöllath et al., 2021). Among sheep/goats that survived early infancy, dental evidence indicates mortality concentrated between six months and two years of age in the earliest occupation horizon, with more adults in later levels (Stiner et al., 2022a:fig. 3a). Sexable pelvises indicate strong selective culling of young males in their first year (ca. 60 % of male acetabula unfused, falling to ca. 15 % in the uppermost levels, compared with ca. 15 % of female acetabula unfused in all levels), but paradoxically survival beyond this age (with fused acetabulum) of fairly similar numbers of males and females in most levels (Stiner et al., 2022a:fig. 2, table S3). Stiner and co-authors proposed three successive strategies of sheep/goat exploitation at Aşıklı Höyük: capture and rearing of young wild animals in the earliest Level 5; reproduction in captivity (effectively domestic management in the conventional sense) in Level 4; and 'large-scale herding' in the uppermost Levels 3–2. We focus here on the proposed transition from hunted to domestic exploitation.

For Level 5, Stiner et al. interpret the lack of evidence for slaughter of adults as indicating a 'catch and grow strategy', with infant lambs and kids captured from the wild and reared on site for consumption (2022a:6). It is highly improbable, however, that captured newborn lambs or kids were successfully raised on-site unless their mothers were also taken alive (or the neonates were suckled by other lactating females, potentially including human foster-mothers – Simoons and Baldwin, 1982). Indeed the foetal and neonatal remains (Stiner et al., 2022a:table 1) imply the presence of live adult females that aborted the former and perhaps suckled the latter (cf. Pöllath et al., 2021), even if skeletal remains of these adult females are lacking. The selective cull of young males, at an age when *wild* lambs/kids of both sexes would still have accompanied their mothers, suggests that young females were deliberately spared as future breeding stock, representing deferred harvest – whether of closely controlled domesticates or of wild animals effectively in private ownership. The ostensibly contradictory indications of mainly male deaths in the first year but of similar male and female survival (rather than superior female survival) thereafter further highlights the underrepresentation on site of adult females, arguably because (as at Ganj Dareh) many breeding females had ultimately been left to die off site of natural causes. This apparent failure to consume 'retired' adult females again favours interpretation of the Level 5 sheep (and perhaps goats) as wild animals in private ownership rather than herded domesticates. As for the foetal/neonatal remains, these might again be attributed parsimoniously to stress-induced abortions and infant deaths in captured nursery herds, corralled on site (potentially for days or even weeks, as sometimes recently on Crete and Kythera) pending selective slaughter or release.

Transition to domestic management in Level 4 is inferred from increasing evidence for slaughter of adults of breeding age and from more intensive deposition of dung. Moreover, among animals surviving beyond the first-year fusion of the acetabulum, females heavily outnumber males in Level 4, so the mortality data are now compatible with a domestic herd. The strong preferential culling of first-year males implies that the predominant sheep, at least, were domestic in Levels 5–4 in the sense proposed by Ingold (see also Stiner et al., 2014:5) but perhaps not, especially in Level 5, in the conventional sense of close management.

3.4. Ungulate mortality in early postglacial southwest Asia: Delayed harvest, ownership and the hunting-herding transition

We may summarise the discussion in the preceding sections as follows:

- For Aceramic Ganj Dareh, claims that selective culling of young males, especially yearlings and older, identifies goats as early domesticates (in the conventional sense) must be rejected because this could equally result from seasonal hunting of *wild* 'bachelor' groups. The apparently selective slaughter of male kids, however, at an age when offspring of both sexes would have accompanied their mothers,

implies the deliberate sparing of first-year (as well as adult and probably subadult) females. This 'deferred harvest' identifies these animals as domestic in the sense of belonging to people at Ganj Dareh but not necessarily in the sense of being herded, while the scarcity of adult female remains, implying that these breeding animals died off site of natural causes, suggests a wild/free-range rather than herded population.

- For the earliest Level 5 at Aceramic Aşıklı Höyük, selective culling of male kids indicates deferred harvest and thus domestication in the sense at least of ownership, but not necessarily of close control, while the underrepresentation on site of adult females can again be attributed to natural off-site deaths more compatible with a wild than a controlled population. Such selective culling and release of trapped wild nursery herds arguably offers a fuller, more parsimonious and ethologically more plausible interpretation of the available evidence than the previous suggestion of capture from the wild and on-site rearing of very young lambs and/or kids.
- Perinatal remains of goats and sheep at Ganj Dareh and Aşıklı Höyük, plausibly attributable to stress-induced abortions and disease-related infant mortality, are compatible with the penning on site of trapped wild animals as well as herded domesticates.

To place these conclusions in context, we next consider: (1) how widespread 'delayed harvest' might have been in early postglacial southwest Asia; (2) how and by whom proprietary claims to wild ruminants might have been made; and (3) the likely implications of delayed harvest and proprietary claims for biological domestication.

3.4.1. How widespread might 'delayed harvest' have been in early postglacial southwest Asia?

For goats at Aceramic Ganj Dareh and perhaps both sheep and goats at Aşıklı Höyük, trapping and selective culling of free-range animals, over which some form of ownership was claimed, may have preceded herded management. It is dangerous to generalise from two cases, but similar exploitation is potentially undetected at other early sites where selective culling of juvenile male caprines is reported with less detail regarding age at death (e.g. sheep and goats at Abu Hureyra) and, if adult females were left to die off site, even (pace Peters et al., 2014:162–4) at sites with heavy juvenile culling without evident sexual bias (e.g. sheep at Aceramic Suberde – Arbuckle, 2008). Few zooarchaeological assemblages of cattle are large enough for detailed analysis, but at 7th millennium BCE Çatal Höyük trapping of uncontrolled animals and a tendency for adult females to die off site of natural causes would parsimoniously account for the ostensibly contradictory indications of 'wild' biometry, anatomical representation suggesting slaughter close to the site, and mortality (heavy adult; moderate juvenile/infant; light subadult) atypical of domestic management (Russell and Martin, 2005; Russell et al., 2005). Indeed, given the tendency at Çatal Höyük for cows to be associated with daily and bulls with ceremonial consumption, Russell and Martin (2005:55) have debated whether acquisition of appropriate carcasses might have involved trapping and penning or attraction to salt licks, with maintenance of the latter perhaps conferring ownership of animals captured there. Exploitation in some way 'intermediate' between hunting and herding has also been debated for pigs, notably at PPNA Hallan Çemi and PPNB Çayönü in eastern Anatolia (Rosenberg et al., 1998; Starkovich and Stiner, 2009; Ervynck et al., 2001; Rowley-Conwy et al., 2012; Peters et al., 2014:153–154; Price and Hongo, 2020), but is not discussed here because of the difficulty of exploring sexually biased mortality in a multiparous species.

Even excluding pigs, proprietary claims to sheep, goats and cattle, exploited by trapping and sexually selective release, may have widely preceded the sort of human control over mobility and thus diet that is conventionally described as 'herding'. Such a trajectory may be compatible with some recent arguments for 'game management' or cultural control as an intermediate stage between hunting and herding (Zeder, 2012:249; Peters et al., 2014:164; Vigne, 2015:130), although

on Cyprus pigs, goats and fallow deer were anthropogenic introductions to the island but arguably hunted rather than trapped alive or herded, given anatomical evidence for their butchery at a distance from PPNB Shillourokamos (Vigne et al., 2011:S266).

3.4.2. How and by whom might proprietary claims to wild ruminants have been made?

Rights might have been claimed to a local wild herd (e.g. if food or water was provided when needed) or to individual animals that had been captured and released (perhaps after marking to indicate ownership) and/or (especially with increasing sedentism and territoriality) to the land over which animals ranged (cf. Alvard and Kuznar, 2001:296-7; Rowley-Conwy et al., 2012:27; Marom and Bar-Oz, 2013). All three scenarios are documented for recent feral/minimally managed goats, cattle and sheep in Greece, although here ownership was claimed by individual (or closely related and cooperating) households.

For early postglacial southwest Asia, increasingly sedentary habitation has been claimed (if not universally accepted) on the basis of a range of archaeological proxies, including the development of commensal faunas, investment in architecture and other non-portable material culture, creation of cemeteries, and stable-isotope evidence for reduced human mobility (e.g., Boyd, 2006; Cucchi et al., 2020; Santana et al., 2021). Among recent hunter-gatherers, sedentism is often associated with territoriality (e.g., Rowley-Conwy, 2001), which in turn is a common basis for claims to ownership over resources. As in the Greek case, however, the larger the social group making such claims, the less secure would have been future enjoyment of deferred harvest (also Hesse, 1984:259-260; Rosenberg and Redding, 1998:59), especially if practised to enhance the abundance or predictability of prey (e.g. Jarman, 1976; Zeder, 2012:249) in the face of pressures on availability such as increasingly dense or sedentary human population (e.g. Redding and Rosenberg, 1998; Legge and Rowley-Conwy, 2000; Davis, 2005) or the demands of periodic feasting (e.g. Peters et al., 2014, 167-70). On the other hand, such claims would have been meaningless unless broadly recognised and, if necessary, collectively defended against outsiders by neighbours with similar interests (e.g. Rosenberg and Redding, 1998:59).

Ganj Dareh (Smith, 1990), Aşıklı Höyük (Stiner et al., 2022b) and Abu Hureyra (Moore, 2000), at least in their better preserved and more extensively explored levels, were large enough that deferred harvest may have been attractive to subdivisions of the co-residential community. Indeed, even at the modest earlier hamlet of Hallan Çemi, the orientation of huts implies an emphasis on privacy running counter to the forager ideal of generalised reciprocity (Rosenberg and Redding, 2000:48). More generally, during the late Epipalaeolithic and early Neolithic in southwest Asia, settlements exhibit increasing 'privatisation' of dwelling space and plant-food storage (e.g. Flannery, 1972; Watkins, 1990; Byrd, 1994; Wright, 2000; 2014; Bogaard et al., 2009; Kuijt, 2011; Duru, 2018; Weide, 2021), perhaps coupled with early Neolithic indications of conflict between neighbouring communities that imply collective defence of key resources (Watkins, 1992).

Architectural ring-fencing of households and associated food stores would have posed challenges to community solidarity that were widely offset by collective consumption events in which carcasses of hunted or herded animals seemingly played an important role (e.g. Peters et al., 2014), but collective consumption may obscure who provided these animals, unless mementos were curated within homes as at Çatal Höyük (Twiss, 2012). At Aşıklı Höyük, stable isotope analysis of human skeletons indicates dietary homogeneity (apparently including animal protein intake) among those buried in the same house but not between houses (Itahashi et al., 2021:fig. 4d), although this might reflect uneven access to commensality rather than control over carcasses *per se*. Evidence of animal penning may shed light on provision (as opposed to consumption) of animal carcasses, however, and in early levels at both Aşıklı Höyük (Stiner et al., 2022b:515-516) and Ganj Dareh (Yeomans et al., 2023:table 2, fig. 7) such deposits are located not in public open

areas but between dwellings and within walled spaces, respectively. This suggests control of captive animals not collectively but by smaller social groups such as 'households' (During and Marciniak, 2006; Kuijt et al., 2011; Duru, 2018). As penning of animals is increasingly recognized within such settlements (e.g. Matthews et al., 2014; Portillo et al., 2020), therefore, temporal and geographical patterns in ownership of animals, as well as stored plants, may emerge.

Penning deposits have also attracted interest in attributing associated plant remains to fodder or pasture (e.g. Portillo et al., 2020; Stiner et al., 2022b), although exclusion of other sources may be challenging (e.g. Ergun, 2018; Ergun, in press). At Aceramic/PPN Abu Hureyra (Hillman, 2000; de Moulins, 2000), Aşıklı Höyük (Ergun et al., 2018) and Ganj Dareh (van Zeist et al., 1984), there is evidence for cultivated grains and the ethnographic evidence reviewed here highlights how modest amounts of cultivated fodder may help to attract or trap feral/free-range goats, sheep, cattle and pigs. On the other hand, leafy browse was also collected traditionally for this purpose and played a significant role in foddering domestic animals, at least in modest numbers (e.g. Forbes, 1998:23-24; Halstead, 1998). Accordingly, archaeobotanical identification of cultivated rather than collected fodder does not distinguish between domestic and wild animals in the traditional management sense. Identification of fodder, however, of whatever composition, is evidence that its consumers were domestic in the sense of being to some extent 'improved or increased by human labour' (Woodburn, 1982:433) and thus likely subject to claims of private ownership.

3.4.3. What are the likely implications of delayed harvest and proprietary claims for biological domestication?

As has been noted for some other forms of 'intermediate' game management or cultural control (Rowley-Conwy et al., 2012:12-13), the trapping and selective release proposed here for Ganj Dareh goats and Aşıklı Höyük sheep and goats is unlikely to have resulted in biological domestication (morphometric change), because most females would have been released for breeding and the heavy cull of young males, that in isolation would have removed selection for large bucks with impressive horns, is likely to have been counteracted by immigration of adult males from neighbouring areas (cf. Redding, 2005, 45 figs. 3-5). On the other hand, in Greece recent owners of feral goats, in common with herders of domestic livestock, selected breeding stock in accordance with ideas of beauty that differed significantly between regions and sometimes between neighbours (Halstead and Isaakidou, submitted), thus reinforcing the role of physical appearance as a marker of ownership. Accordingly, aDNA evidence that Aceramic Neolithic goats at Ganj Dareh were already genetically distinct from the local wild population (Daly et al., 2021) may be as compatible with private ownership, mass capture and sexually selective release as with domestic management in the conventional sense.

4. Conclusion

While it has long been recognised that human exploitation of animals is far more diverse than the traditional wild:domestic dichotomy implies, this understanding has rested largely on our relations with species other than the classic Old World 'farmyard animals' (e.g. Wilkinson, 1972; Ingold, 1980) or in regions distant from their suspected hearths of domestication (e.g. Dwyer, 1996). Accordingly, recent 'hands-off' exploitation in Greece of privately owned but feral/minimally controlled groups of goats, sheep, cattle and pigs is a valuable addition to potential analogues for ancient human-animal relations (cf. Redding and Rosenberg, 1998:65; Redding, 2005).

It may be objected that these animals are descended from domesticates that had undergone long-term selection against wariness of humans (e.g. Zeder, 2012:232) and so may have been more amenable than their wild ancestors to accepting food or water from people. Anecdotal support for this concern comes from the observation by some

Greek hunters that wild boar today, having interbred with escaped or released feral/domestic pigs, lack the innate wariness of humans that characterised boar just a few years ago. Similar changes are reported for genetically unaltered brown bear, however, in response to long-term rural depopulation and the shorter-term national 'lockdown' for Covid-19. Moreover, food has been used successfully to control species not usually considered to have been domesticated (e.g. Jarman, 1976). Conversely, once close and frequent contact with the herder is relaxed, Greek domestic sheep, goats, cattle and pigs consistently avoid humans and adopt patterns of social behaviour similar to those of their wild relatives, consistent with the conclusion of Shackleton and Shank (1984) that both goats and sheep exhibit more similarities than differences of behaviour between feral and wild populations. A consistent feature of the oral testimonies summarised above is that, just as domestic animals vary in their acceptance of close control, their feral counterparts are likewise more or less susceptible to being attracted to offers of water or food. The successful domestication in postglacial southwest Asia of the species discussed here surely implies that their wild ancestors too included individuals that responded positively to such blandishments.

As well as blurring the traditional distinction between uncontrolled wild and controlled domestic populations, the recent Greek cases confirm the potential dangers of drawing such a distinction zooarchaeologically on the basis of apparently selective culling of young males in social ungulates that tend to seasonal sexual segregation in the wild. They also suggest that caution is needed in interpreting on-site remains of herbivore dung, perinatal animals and shed deciduous teeth as evidence for penning of conventionally domestic livestock, since all these traces may, at least in modest quantities, result from short-term corralling and/or slaughter of wild or feral captives.

More positively, the modern Greek data suggest avenues for zooarchaeological recognition of human ownership of such social ungulates and for reinterpreting some of the key faunal assemblages in narratives of Old-World animal domestication. First, sexually biased culling among very young animals (e.g. first-year kids/lambs), still associated with the maternal nursery herd, offers a more secure indication of human selectivity than that widely claimed among older juveniles (e.g. yearling goats/sheep) and thus documents deferred harvesting and, by extension, human ownership – albeit of either free-range wild or controlled domestic animals. Secondly, whether breeding females were left to die at pasture of natural causes or were culled for consumption can differentiate between free-range wild (but perhaps privately owned) and controlled domestic herds, respectively.

Exploration of these suggestions demands higher-resolution, sex-specific mortality data than are currently available from most early postglacial sites in southwest Asia. The high-resolution data from 9th–8th millennia BCE Aşıklı Höyük and Ganj Dareh, however, are compatible with trapping and selective release of privately owned goats and/or sheep before their domestication in the sense of controlled management, while smaller or lower-resolution datasets from other sites may conceal a similar trajectory. Accordingly, ownership of animals, for Ducos and Ingold the key distinction between wild and domestic and arguably a pre-requisite of domestication in the conventional sense of controlled management, may widely have preceded the latter. Chronologically, these indications that ungulates, otherwise seemingly free of human control, were subject to deferred harvest and hence proprietary claims broadly coincide with changes in settlement organisation that are thought to represent progressive 'privatisation' of residential space and food storage. Thanks to emerging spatial analysis of dung deposits, representing on-site penning, it will soon be possible to explore the role of rights to live animals, as well as stored plant foods, in this fundamental social transformation.

Drawing on recent use of feral and minimally controlled domesticates in Greece, we have challenged some existing accounts of changing ungulate exploitation in early postglacial southwest Asia, but have largely avoided the thorny question of why hunting gave way to herding. In closing, we note one respect in which our ethnographic data may

shed light on this question. Some scholars have linked an apparent diversity of earliest Neolithic exploitation of the future farmyard species to a lengthy process of 'learning by doing' (Peters et al., 2014:164) and to incremental improvements in technical sophistication (Vigne et al., 2011:S265–267). The Greek ethnography, however, highlights the wealth of ecological and ethological understanding that is not only passed down by older practitioners, but also acquired first-hand by observant owners of feral/free-range animals (as well as herders and hunters) over at most a few decades of self-taught 'learning by doing'. Indeed, a few decades ago on Crete, some men had by early adulthood already acquired sufficient expertise to capture and tame the feral goats that subsequently formed the core of their own domestic herd. Unless we assume, implausibly, that regular hunters of wild progenitors in early postglacial southwest Asia lacked such powers of observation, they will have possessed the requisite knowledge both for driving/trapping of wild animals and for close husbandry of domestic livestock. Domestication in the latter sense, therefore, seems less likely to have been enabled by long-term accumulation of technical expertise than by contingent circumstances, such as erosion of a classic hunter-gatherer ethos of sharing in favour of expanding acceptance of private property or, more specifically, of ownership of particular groups of animals in the context of increasing sedentism and territoriality. In this respect, the private ownership of otherwise 'wild' (free-range) animals, as proposed here for the earliest Neolithic at Ganj Dareh and Aşıklı Höyük, would satisfy one significant prerequisite for close domestic management. As for the switch from driving/trapping to close management, our ethnographic sources suggest that, at least (but perhaps not only) in a predator-free insular environment, the much greater labour demands of the latter form of exploitation are worthwhile only if herds are exploited for milk as well as meat (Halstead and Isaakidou, 2024:91). The earliest domestic (i.e. closely controlled) ruminants may well have been milked given that lipid residues of dairy fats in ceramic vessels are found in the earliest pottery in Neolithic southwest Asia (Evershed et al., 2008).

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CRedit authorship contribution statement

Paul Halstead: Writing – review & editing, Writing – original draft, Investigation, Funding acquisition. **Valasia Isaakidou:** Writing – review & editing, Visualization, Investigation, Funding acquisition, Conceptualization. **Nasia Makarouna:** Writing – review & editing, Investigation.

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REFERENCES

- Abell, J.T., Quade, J., Duru, G., Mentzer, S.M., Stiner, M.C., Uzdurum, M., Özbaşaran, M., 2019. Urine salts elucidate Early Neolithic animal management at Aşıklı Höyük, Turkey. *Sci. Adv.* 5 (4), eaaw0038. <https://doi.org/10.1126/sciadv.aaw0038>.
- Alvard, M., 1995. Intraspecific prey choice by Amazonian hunters. *Curr. Anthropol.* 36 (5), 789–818. <https://doi.org/10.1086/204432>.
- Alvard, M.S., Kuznar, L., 2001. Deferred harvests: the transition from hunting to animal husbandry. *Am. Anthropol.* 103, 295–311. <https://doi.org/10.1525/aa.2001.103.2.295>.
- Arbuckle, B.S., 2005. Experimental domestication and its application to the study of animal exploitation in prehistory. In: Vigne, J.-D., Peters, J., Helmer, D. (Eds.), *The First Steps of Animal Domestication: New Archaeozoological Approaches*. Oxbow, Oxford, pp. 18–33.
- Arbuckle, B.S., 2008. Revisiting Neolithic caprine exploitation at Suberde, Turkey. *J. Field Archaeol.* 33, 219–236. <https://doi.org/10.1179/009346908791071277>.
- Atici, L., 2009. Implications of age structures for Epipaleolithic hunting strategies in the western Taurus Mountains, southwest Turkey. *Anthropozoologica* 44 (1), 13–39. <https://doi.org/10.5252/az2009n1a1>.
- Bar-Oz, G., Dayan, T., Kaufman, D., Weinstein-Evron, M., 2004. The Natufian economy at el-Wad Terrace with special reference to gazelle exploitation patterns. *J. Archaeol. Sci.* 31, 217–231. <https://doi.org/10.1016/j.jas.2003.08.003>.
- Bar-Oz, G., Yeshurun, R., Weinstein-Evron, M., 2013. Specialized hunting of gazelle in the Natufian: cultural cause or climatic effect? In: Bar-Yosef, O., Valla, F.R. (Eds.), *Natufian Foragers in the Levant: Terminal Pleistocene Social Changes in Western Asia*. International Monographs in Prehistory, Ann Arbor, pp. 685–698.
- Black-Michaud, J., 1986. *Sheep and Land: the Economics of Power in a Tribal Society*. Cambridge University Press, Cambridge.
- Bogaard, A., Charles, M., Twiss, K.C., Fairbairn, A., Yalman, N., Filipović, D., Arzu Demirergi, G., Ertuğ, F., Russell, N., Henneke, J., 2009. Private pantries and celebrated surplus: storing and sharing food at Neolithic Çatalhöyük, Central Anatolia. *Antiquity* 83, 649–668. <https://doi.org/10.1017/S0003598X00098896>.
- Bökönyi, S., 1989. Definitions of animal domestication. In: Clutton-Brock, J. (Ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation*. Unwin Hyman, London, pp. 22–27.
- Bon, R., Campana, R., 1989. Social tendencies of the Corsican mouflon *Ovis ammon musimon* in the Caroux-Espinouse massif (South of France). *Behav. Process.* 19, 57–78. [https://doi.org/10.1016/0376-6357\(89\)90031-4](https://doi.org/10.1016/0376-6357(89)90031-4).
- Bon, R., Cugnasse, J.M., Dubray, D., Gilbert, P., Houard, T., Rigaud, P., 1991. Le mouflon de Corse. *Revue d'Écologie (la Terre et la Vie) Suppl.* 6, 67–110. <https://doi.org/10.3406/rev.1991.6323>.
- Bouissou, M.-F., Boissy, A., Le Neindre, P., Veissier, I., 2001. The social behaviour of cattle. In: Keeling, L.J., Gonyou, H.W. (Eds.), *Social Behaviour in Farm Animals*. CAB International Publishing, Wallingford UK, pp. 113–145.
- Boyd, B., 2006. On 'sedentism' in the Later Epipaleolithic (Natufian) Levant. *World Archaeol.* 38, 164–178. <https://doi.org/10.1080/00438240600688398>.
- Byrd, B.F., 1994. Public and private, domestic and corporate: the emergence of the southwest Asian village. *Am. Antiq.* 59 (4), 639–666. <https://doi.org/10.2307/282338>.
- Chaplin, R., 1969. The use of non-morphological criteria in the study of animal domestication from bones found on archaeological sites. In: Ucko, P., Dimbleby, G. (Eds.), *The Domestication & Exploitation of Plants & Animals*. Duckworth, London, pp. 231–245.
- Clutton-Brock, J., 1989. Introduction to domestication. In: Clutton-Brock, J. (Ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation*. Unwin Hyman, London, pp. 7–9.
- Collier, S., White, J.P., 1976. Get them young? Age and sex inferences on animal domestication in archaeology. *Am. Antiq.* 41 (1), 96–102. <https://doi.org/10.2307/279046>.
- Conolly, J., Colledge, S., Dobney, K., Vigne, J.-D., Peters, J., Stopp, B., Manning, K., Shennan, S., 2011. Meta-analysis of zooarchaeological data from SW Asia and SE Europe provides insight into the origins and spread of animal husbandry. *J. Archaeol. Sci.* 38 (3), 538–545. <https://doi.org/10.1016/j.jas.2010.10.008>.
- Cribb, R., 1991. *Nomads in Archaeology*. Cambridge University Press, Cambridge.
- Cucchi, T., Papayianni, K., Cersoy, S., Aznar-Cormano, L., Zazzo, A., Debruyne, R., Berthon, R., Bălăşescu, A., Simmons, A., Valla, F., Hamilakis, Y., Mavridis, F., Mashkour, M., Darvish, J., Siahsharvi, R., Biglari, F., Petrie, C.A., Weeks, L., Sardari, A., Maziar, S., Denys, C., Orton, D., Jenkins, E., Zeder, M.A., Searle, J.B., Larson, G., Bonhomme, F., Auffray, J.-C., Vigne, J.-D., 2020. Tracking the Near Eastern origins and European dispersal of the western house mouse. *Sci. Rep.* 10, 8726.
- Daly, K.G., Mattiangeli, V., Hare, A.J., Davoudi, H., Fathi, H., Doost, S.B., Amiri, S., Khazaei, R., Decruyenaere, D., Nokandeh, J., Richter, T., Darabi, H., Mortensen, P., Pantos, A., Yeomans, L., Bangsgaard, P., Mashkour, M., Zeder, M.A., Bradley, D.G., 2021. Herded and hunted goat genomes from the dawn of domestication in the Zagros Mountains. *PNAS* 118 (25). <https://doi.org/10.1073/pnas.2100901118>.
- Davis, S.J.M., 1983. The age profiles of gazelles predated by ancient man in Israel: possible evidence for a shift from seasonality to sedentism in the Natufian. *Paléorient* 9 (1), 55–62. <https://doi.org/10.3406/PALEO.1983.4331>.
- Davis, S.J.M., 2005. Why domesticate food animals? Some zoo-archaeological evidence from the Levant. *J. Archaeol. Sci.* 32, 1408–1416. <https://doi.org/10.1016/j.jas.2005.03.018>.
- Daycard, L., 1990. Structure sociale de la population de bovins sauvages de l'île Amsterdam, sud de l'Océan Indien. *Revue d'Écologie (la Terre et la Vie)* 45 (1), 35–53. <https://doi.org/10.3406/rev.1990.1981>.
- de Moulins, D., 2000. Abu Hureyra 2: plant remains from the Neolithic. In: Moore, A.M.T., Hillman, G.C., Legge, A.J. (Eds.), *Village on the Euphrates: from Foraging to Farming at Abu Hureyra*. Oxford University Press, Oxford, pp. 399–415.
- Driver, J.C., Maxwell, D., 2013. Bison death assemblages and the interpretation of human hunting behaviour. *Quat. Int.* 297, 100–109. <https://doi.org/10.1016/j.quaint.2012.12.038>.
- Ducos, P., 1978. 'Domestication' defined and methodological approaches to its recognition in faunal assemblages. In: Meadow, R.H., Zeder, M.A. (Eds.), *Approaches to Faunal Analysis in the Middle East*. Peabody Museum, Harvard, pp. 53–56.
- Ducos, P., 1989. Defining domestication: a clarification. In: Clutton-Brock, J. (Ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation*. Unwin Hyman, London, pp. 28–30.
- Ducos, P., 1993. Proto-élevage et élevage au Levant Sud au VII^e millénaire B.C.: les données de la Damascène. *Paléorient* 19 (1), 153–173. <https://doi.org/10.3406/paleo.1993.4589>.
- Düring, B.S., Marciniak, A., 2006. Households and communities in the central Anatolian Neolithic. *Archaeological Dialogues* 12, 165–187. <https://doi.org/10.1017/S138020380600170X>.
- Duru, G., 2018. Sedentism and solitude: exploring the impact of private space on social cohesion in the Neolithic. In: Hodder, I. (Ed.), *Religion, History and Place in the Origin of Settled Life*. University Press of Colorado, Louisville, pp. 162–185.
- Dwyer, P.D., 1996. Boars, barrows, and breeders: the reproductive status of domestic pig populations in mainland New Guinea. *J. Anthropol. Res.* 52, 481–500. <https://doi.org/10.1086/jar.52.4.3630298>.
- Edge, W.D., Olson-Edge, S.L., 1990. Population characteristics and group composition of *Capra aegagrus* in Kirthar National Park, Pakistan. *Journal of Mammalogy* 71 (2), 156–160. <https://doi.org/10.2307/1382162>.
- Ergun, M., 2018. 'Where the wild things are'. Contextual insights into wild plant exploitation at Aceramic Neolithic Aşıklı Höyük, Turkey. *Paléorient* 44 (2), 9–28.
- Ergun, M., Tengberg, M., Willcox, G., Douché, C., 2018. Plants of Aşıklı Höyük and changes through time: first archaeobotanical results from the 2010–14 excavation seasons. In: Özbaşaran, M., Duru, G., Stiner, M. (Eds.), *The Early Settlement at Aşıklı Höyük: Essays in Honor of Ufuk Esin*. Ege Yayınları, İstanbul, pp. 191–217.
- Ergun, M., in press. Plant food related activities in an Early Neolithic sedentary community in volcanic Cappadocia: an archaeobotanical glimpse into daily occupations. In: Dietrich, L., Ergun, M., Galik, A., Lehnig, S. (Eds.), *Food in Anatolia and Its Neighbouring Regions*. German Archaeology Institute (DAI) Istanbul Department, Zero Books/Ege Yayınları, İstanbul.
- Ervynck, A., Dobney, K., Hongo, H., Meadow, R., 2001. Born free? New evidence for the status of 'Sus scrofa' at Neolithic Çayönü Tepe (southeastern Anatolia, Turkey). *Paléorient* 27 (2), 47–73. <https://doi.org/10.3406/PALEO.2001.4731>.
- Evershed, R.P., Payne, S., Sherratt, A.G., Copley, M.S., Coolidge, J., Urem-Kotsu, D., Kotsakis, K., Özdoğan, M., Özdoğan, A.E., Nieuwenhuyse, O., Akkermans, P.M.M.G., Bailey, D., Andeescu, R.-R., Campbell, S., Farid, S., Hodder, I., Yalman, N., Özbaşaran, M., Bıçkıcı, E., Garfinkel, Y., Levy, T., Burton, M.M., 2008. Earliest date for milk use in the Near East and southeastern Europe linked to cattle herding. *Nature* 455, 528–531. <https://doi.org/10.1038/nature07180>.
- Flannery, K.V., 1972. The origins of the village as a settlement type in Mesoamerica and the Near East: a comparative study. In: Ucko, P.J., Tringham, R., Dimbleby, G.W. (Eds.), *Man, Settlement and Urbanism*. Duckworth, London, pp. 23–53.
- Forbes, H., 1998. European agriculture viewed bottom-side upwards: fodder- and forage-provision in a traditional Greek community. *Environ. Archaeol.* 1, 19–34. <https://doi.org/10.1179/env.1996.1.1.19>.
- Frädrich, H., 1974. A comparison of behaviour in the Suidae. In: Geist, V., Walther, F. (Eds.), *The Behaviour of Ungulates and its Relation to Management*. International Union for Conservation of Nature and Natural Resources, Morges, pp. 133–143.
- Garel, M., Cugnasse, J.-M., Maillard, D., Gaillard, J.-M., Hewison, A.J.M., Dubray, D., 2007. Selective harvesting and habitat loss produce long-term life history changes in a mouflon population. *Ecol. Appl.* 17 (6), 1607–1618. <https://doi.org/10.1890/06-0898.1>.
- Garrard, A., 1984. The selection of southwest Asian animal domesticates. In: Clutton-Brock, J., Grigson, C. (Eds.), *Animals and Archaeology 3*. BAR International Series 202, Oxford, pp. 117–132.
- Georgoudi, S., 1989. Sanctified slaughter in modern Greece: the 'kourbânia' of the saints. In: Detienne, M., Vernant, J.-P. (Eds.), *The Cuisine of Sacrifice among the Greeks*. Chicago University Press, Chicago, pp. 183–203.
- Geskos, A.F., 2009. Agrimi on Lefka Ori, Crete: population status, threats and conservation. *Caprinae: Newsletter of the IUCN/SSC Caprinae Specialist Group*, 2–5.
- Groves, C.P., 1989. Feral mammals of the Mediterranean islands: documents of early domestication. In: Clutton-Brock, J. (Ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation*. Unwin Hyman, London, pp. 46–58.
- Grubb, P., 1974. Mating activity and the social significance of rams in a feral sheep community. In: Geist, V., Walther, F. (Eds.), *The Behaviour of Ungulates and its Relation to Management Volume 1*. International Union for Conservation of Nature and Natural Resources, Morges, pp. 457–476.
- Grubb, P., Jewell, P.A., 1966. Social grouping and home range in feral Soay sheep. In: Jewell, P.A., Loizos, C. (Eds.), *Play, Exploration and Territory in Mammals*.

- Symposia of the Zoological Society of London 18. Academic Press, London, pp. 179–210.
- Gundogdu, E., Ogurlu, I., 2009. The distribution of wild goat *Capra aegagrus* Erxleben 1877 and population characteristics in Isparta, Turkey. *J. Anim. Vet. Adv.* 8 (11), 2318–2324. <https://medwelljournals.com/abstract/?doi=javaa.2009.2318.2324>.
- Halstead, P., 1998. Ask the fellows who lop the hay: leaf-fodder in the mountains of northwest Greece. *Rural. Hist.* 9 (2), 211–234. <https://doi.org/10.1017/S0956793300001588>.
- Halstead, P., Isaakidou, V., 2011. A pig fed by hand is worth two in the bush: ethnoarchaeology of pig husbandry in Greece and its archaeological implications. In: Albarella, U., Trentacoste, A. (Eds.), *Ethnozoarchaeology: the Present and past of Human-Animal Relationships*. Oxbow, Oxford, pp. 160–174.
- Halstead, P., Isaakidou, V., 2024. Management of feral goats *Capra hircus* Linnaeus, 1758 in insular southern Greece: implications for prehistory. *Anthropozoologica* 59 (6), 77–95. <https://doi.org/10.5252/anthropozoologica2024v58a6>.
- Halstead, P., Isaakidou, V., submitted. Mobility of people and livestock in ancient Greece: shifting archaeological methods and models. In: Kiriati, E., Lis, B., Karamanes, E., Potiropoulos, P. (Eds.), *Craftspeople Mobility in the Archaeological and Ethnographic Record: Comparative Perspectives from the Aegean*. Cambridge University Press, Cambridge.
- Hames, R., 2007. The ecologically noble savage debate. *Ann. Rev. Anthropol.* 36, 177–190. <https://doi.org/10.1146/annurev.anthro.35.081705.123321>.
- Hesse, B., 1982. Slaughter patterns and domestication: the beginnings of pastoralism in western Iran. *Man* 17 (3), 403–417. <https://doi.org/10.2307/2801705>.
- Hesse, B., 1984. These are our goats: the origins of herding in west central Iran. In: Clutton-Brock, J., Grigson, C. (Eds.), *Animals and Archaeology 3: Early Herders and their Flocks*. BAR International Series 202, Oxford, pp. 243–265.
- Higgs, E.S., Jarman, M.R., 1969. The origins of agriculture: a reconsideration. *Antiquity* 43, 31–41. <https://doi.org/10.1017/S0003598X00039958>.
- Hillman, G.C., 2000. Overview: the plant-based components of subsistence in Abu Hureyra 1 and 2. In: Moore, A.M.T., Hillman, G.C., Legge, A.J. (Eds.), *Village on the Euphrates: from Foraging to Farming at Abu Hureyra*. Oxford University Press, Oxford, pp. 416–422.
- Hole, F., Flannery, K., 1968. The prehistory of southwestern Iran: a preliminary report. *Proc. Prehist. Soc.* 33, 147–206. <https://doi.org/10.1017/S0079497X00014092>.
- Husband, T.P., Davis, P.B., 1984. Ecology and behavior of the Cretan agrimi. *Can. J. Zool.* 62, 411–420. <https://doi.org/10.1139/z84-064>.
- Ingold, T., 1980. *Hunters, Pastoralists and Ranchers: Reindeer Economies and their Transformations*. Cambridge University Press, Cambridge.
- Ingold, T., 1986. *The Appropriation of Nature: Essays on Human Ecology and Social Relations*. Manchester University Press, Manchester.
- Isaakidou, V., Halstead, P., 2021. The 'wild' goats of ancient Crete: ethnographic perspectives on iconographic, textual and zooarchaeological sources. In: Laffineur, R., Palaima, T.G. (Eds.), *Zoia. Animal-Human Interactions in the Aegean Middle and Late Bronze Age*. Aegaeum 45. Peeters, Leuven, pp. 51–62.
- Itahashi, Y., Stiner, M.C., Erdal, O.D., Duru, G., Erdal, Y.S., Miyake, Y., Güral, D., Yoneda, M., Özbaşaran, M., 2021. The impact of the transition from broad-spectrum hunting to sheep herding on human meat consumption: multi-isotopic analyses of human bone collagen at Aşıklı Höyük Turkey. *J. Archaeol. Sci.* 136, 105505. <https://doi.org/10.1016/j.jas.2021.105505>.
- Jarman, M.R., 1971. Culture and economy in the north Italian Neolithic. *World Archaeol.* 2 (3), 255–265. <https://doi.org/10.1080/00438243.1971.9979479>.
- Jarman, M.R., 1976. Early animal husbandry. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 275 (936 The Early History of Agriculture), 85–94. <https://doi.org/10.1098/rstb.1976.0072>.
- Jarman, M.R., Wilkinson, P.F., 1972. Criteria of animal domestication. In: Higgs, E.S. (Ed.), *Papers in Economic Prehistory*. Cambridge University Press, Cambridge, pp. 83–96.
- Koike, H., Ohtaishi, N., 1987. Estimation of prehistoric hunting rates based on the age composition of sika deer (*Cervus nippon*). *J. Archaeol. Sci.* 14, 251–269. [https://doi.org/10.1016/0305-4403\(87\)90014-8](https://doi.org/10.1016/0305-4403(87)90014-8).
- Koster, H.A., 1977. *The Ecology of Pastoralism in Relation to Changing Patterns of Land Use in the Northeast Peloponnese*. University of Pennsylvania. PhD dissertation.
- Kugler, W., 2010. *Rare Breeds and Varieties of Greece Atlas 2010*. Synonyms, Occurrence, Description of Rare Breeds and Varieties in Greece. Monitoring Institute for Rare Breeds and Seeds in Europe, St. Gallen.
- Kuijt, I., 2011. Home is where we keep our food: the origins of agriculture and late pre-pottery Neolithic food storage. *Paléorient* 37 (1), 137–152. <https://doi.org/10.3406/paleo.2011.5444>.
- Kuijt, I., Guerrero, E., Molist, M., Anfruns, J., 2011. The changing Neolithic household: household autonomy and social segmentation, Tell Halula, Syria. *J. Anthropol. Archaeol.* 30, 502–522. <https://doi.org/10.1016/j.jaa.2011.07.001>.
- Lazo, A., 1992. Facteurs déterminants du comportement grégaire de bovins retournés à l'état sauvage. *Revue d'Écologie (la Terre et la Vie)* 47 (1), 51–66. <https://doi.org/10.3406/rev.1992.2052>.
- Le Pendu, Y., Maublan, M.-L., Briederma, L., Dubois, M., 1996. Spatial structure and activity in groups of Mediterranean mouflon (*Ovis gmelini*): a comparative study. *Appl. Anim. Behav. Sci.* 46, 201–216. [https://doi.org/10.1016/0168-1591\(95\)00660-5](https://doi.org/10.1016/0168-1591(95)00660-5).
- Legge, A.J., 1972. Prehistoric exploitation of the gazelle in Palestine. In: Higgs, E.S. (Ed.), *Papers in Economic Prehistory*. Cambridge University Press, Cambridge, pp. 119–124.
- Legge, A.J., Rowley-Conwy, P.A., 1987. Gazelle killing in Stone Age Syria. *Sci. Am.* 257 (2), 88–95. <https://doi.org/10.1038/scientificamerican0887-88>.
- Legge, A.J., Rowley-Conwy, P.A., 1988. Star Carr Revisited. A Re-Analysis of the Large Mammals. Centre for Extra-Mural Studies, University of London.
- Legge, A.J., Rowley-Conwy, P.A., 2000. The exploitation of animals. In: Moore, A.M.T., Hillman, G.C., Legge, A.J. (Eds.), *Village on the Euphrates: from Foraging to Farming at Abu Hureyra*. Oxford University Press, Oxford, pp. 423–471.
- Loukopoulos, D., 1930. *Poimenika tis Roumelis*. I.N. Sideris, Athens.
- Macar, O., Gürkan, B., 2009. Observations on behavior of wild goat (*Capra aegagrus*, Erxleben 1777). *Haceteepe J. Biol. Chem.* 37 (1), 13–21.
- Makarewicz, C., Tuross, N., 2012. Finding fodder and tracking transhumance: isotopic detection of goat domestication processes in the Near East. *Curr. Anthropol.* 53 (4), 495–505. <https://doi.org/10.1086/665829>.
- Marom, N., Bar-Oz, G., 2013. The prey pathway: a regional history of cattle (*Bos taurus*) and pig (*Sus scrofa*) domestication in the northern Jordan Valley Israel. *Plos ONE* 8 (2), e55958.
- Martin, L., 2000. Gazelle (*Gazella* spp.) behavioural ecology: predicting animal behaviour for prehistoric environments in south-west Asia. *J. Zool. London* 250, 13–30. <https://doi.org/10.1111/j.1469-7998.2000.tb00574.x>.
- Martin, L., Edwards, Y., 2013. Diverse strategies: evaluating the appearance and spread of domestic caprines in the southern Levant. In: Colledge, S., Conolly, J., Dobney, K., Manning, K., Shennan, S. (Eds.), *The Origins and Spread of Stock-Keeping in the near East and Europe*. Left Coast Press, Walnut Creek, pp. 49–82.
- Martínez, F., 1991. Ramaderia. In: Martínez, F., Palanca, F., Temes d' Etnografia Valenciana 2: Utilitatge Agrícola i Ramaderia. Institució Valenciana d' Estudis i Investigació, Valencia, pp. 183–298.
- Matthews, W., Shillito, L.-M., Elliott, S., Bull, I.D., Williams, J., 2014. Neolithic lifeways: microstratigraphic traces within houses, animal pens and settlements. In: Whittle, A., Bickle, P. (Eds.), *Early Farmers: the View from Archaeology and Science*. Proceedings of the British Academy 198. Oxford University Press for The British Academy, Oxford, pp. 251–279. <https://doi.org/10.5871/bacad/9780197265758.001.0001>.
- Meadow, R.H., 1989. Osteological evidence for the process of animal domestication. In: Clutton-Brock, J. (Ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation*. Unwin Hyman, London, pp. 80–90.
- Mentzer, S.M., 2018. Micromorphological analyses of anthropogenic materials and insights into tell formation processes at Aşıklı Höyük, 2008–2012 field seasons. In: Özbaşaran, M., Duru, G., Stiner, M. (Eds.), *The Early Settlement at Aşıklı Höyük: Essays in Honor of Ufuk Esin*. Ege Yayınları, Istanbul, pp. 105–128.
- Moore, A.M.T., 2000. The buildings and layout of Abu Hureyra 2. In: Moore, A.M.T., Hillman, G.C., Legge, A.J. (Eds.), *Village on the Euphrates: from Foraging to Farming at Abu Hureyra*. Oxford University Press, Oxford, pp. 261–275.
- Munro, N., 2009. Epipaleolithic subsistence intensification in the southern Levant: the faunal evidence. In: Hublin, J.-J., Richards, M.P. (Eds.), *The Evolution of Hominin Diets: Integrating Approaches to the Study of Palaeolithic Subsistence*. Springer, Dordrecht, pp. 141–155.
- Munro, N.D., Bar-Oz, G., Hill, A.C., 2011. An exploration of character traits and linear measurements for sexing mountain gazelle (*Gazella gazella*) skeletons. *J. Archaeol. Sci.* 38, 1253–1265. <https://doi.org/10.1016/j.jas.2011.01.001>.
- Mysterud, A., 2011. Selective harvesting of large mammals: how often does it result in directional selection? *J. Appl. Ecol.* 48, 827–834. <https://doi.org/10.1111/j.1365-2664.2011.02006.x>.
- Neuberger, F.M., Pöllath, N., Peters, J., 2019. Diet of wild versus culturally controlled caprines in early Neolithic Anatolia based on stable carbon isotope analysis of bone apatite. In: Peters, J., McGlynn, G., Goebel, V. (Eds.), *Animals: Cultural Identifiers in Ancient Societies?* Verlag Marie Leidorf GmbH, Leidorf, pp. 251–260.
- Nicholson, M.C., Husband, T.P., 1992. Diurnal behavior of the agrimi, *Capra aegagrus*. *J. Mammal.* 73 (1), 135–142. <https://doi.org/10.2307/1381874>.
- Papadopol, Z., 2017. *Ston kairo tis skholis* (Vincent, A. commentary; Deligiannaki, N. trans. and ed.). Panepistimiakes Ekdoseis Kritis (L'Occio), Heraklio.
- Payne, S., 1973. Kill-off patterns in sheep and goats: the mandibles from Aşvan Kale. *Anatol. Stud.* 23, 281–303. <https://doi.org/10.2307/3642547>.
- Peacock, E., 1998. Historical and applied perspectives on prehistoric land use in eastern North America. *Environ. History* 4 (1), 1–29. <https://doi.org/10.3197/096734098779555727>.
- Peters, J., Helmer, D., von den Driesch, A., Segui, M.S., 1999. Early animal husbandry in the northern Levant. *Paléorient* 25 (2), 27–48. <https://doi.org/10.3406/paleo.1999.4685>.
- Peters, J., von den Driesch, A., Helmer, D., 2005. The upper Euphrates-Tigris basin: cradle of agro-pastoralism? In: Vigne, J.-D., Peters, J., Helmer, D. (Eds.), *The First Steps of Animal Domestication: New Archaeozoological Approaches*. Oxbow, Oxford, pp. 96–124.
- Peters, J., Arbuckle, B.S., Pöllath, N., 2014. Subsistence and beyond: animals in Neolithic Anatolia. In: Özdoğan, M., Başgelen, N., Kuniyol, P. (Eds.), *The Neolithic in Turkey*. Archaeology and Art Publications, Istanbul, pp. 135–203.
- Plumakis, A.G., 2001. To agrimi tis Kritis: *Capra aegagrus cretica*. A.G. Plumakis, Chania.
- Pöllath, N., García-González, R., Kevork, S., Mutze, U., Zimmermann, M.I., Özbaşaran, M., Peters, J., 2021. A non-linear prediction model for ageing foetal and neonatal sheep reveals basic issues in early neolithic husbandry. *J. Archaeol. Sci.* 130, 105344. <https://doi.org/10.1016/j.jas.2021.105344>.
- Popkin, P.R.W., Baker, P., Worley, F., Payne, S., Hammon, A., 2012. The Sheep Project (1): determining skeletal growth, timing of epiphyseal fusion and morphometric variation in unimproved Shetland sheep of known age, sex, castration status and nutrition. *J. Archaeol. Sci.* 39, 1775–1792. <https://doi.org/10.1016/j.jas.2012.01.018>.
- Portillo, M., García-Suárez, A., Matthews, W., 2020. Livestock faecal indicators for animal management, penning, foddering and dung use in early agricultural built environments in the Konya Plain Central Anatolia. *Archaeol. Anthropol. Sci.* 12, 40. <https://doi.org/10.1007/s12520-019-00988-0>.
- Price, M., Hongo, H., 2020. The archaeology of pig domestication in Eurasia. *J. Archaeol. Res.* 28, 557–615. <https://doi.org/10.1007/s10814-019-09142-9>.

- Redding, R.W., 1981. Decision Making in Subsistence Herding of Sheep and Goats in the Middle East. University of Michigan. PhD dissertation.
- Redding, R.W., 2005. Breaking the mold: a consideration of variation in the evolution of animal domestication. In: Vigne, J.-D., Peters, J., Helmer, D. (Eds.), *The First Steps of Animal Domestication: New Archaeozoological Approaches*. Oxbow, Oxford, pp. 41–48.
- Redding, R.W., Rosenberg, M., 1998. Ancestral pigs: a new (Guinea) model for pig domestication in the Middle East. *MASCA Res. Papers Sci. Archaeol.* 15, 65–76.
- Rosenberg, M., Redding, R.W., 1998. Early pig husbandry in southwestern Asia and its implications for modeling the origins of food production. *MASCA Res. Papers Sci. Archaeol.* 15, 55–64.
- Rosenberg, M., Redding, R.W., 2000. Hallan Çemi and early village organization in eastern Anatolia. In: Kuijt, I. (Ed.), *Life in Neolithic Farming Communities: Social Organization, Identity, and Differentiation*. Kluwer Academic/Plenum Publishers, New York, pp. 39–61.
- Rosenberg, M., Nesbitt, R.M., Redding, R., Peasnell, B.L., 1998. Hallan Çemi, pig husbandry, and post-pleistocene adaptations along the Taurus-Zagros Arc (Turkey). *Paléorient* 24 (1), 25–41. <https://doi.org/10.3406/PALEO.1998.4667>.
- Rowley-Conwy, P., 2001. Time, change and the archaeology of hunter-gatherers: how original is the 'Original Affluent Society'? In: Panter-Brick, C., Layton, R.H., Rowley-Conwy, P. (Eds.), *Hunter-Gatherers: An Interdisciplinary Perspective*. Cambridge University Press, Cambridge, pp. 39–72.
- Rowley-Conwy, P., Albarella, U., Dobney, K., 2012. Distinguishing wild boar from domestic pigs in prehistory: a review of approaches and recent results. *J. World Prehist.* 25 (1), 1–44. <https://doi.org/10.1007/s10963-012-9055-0>.
- Russell, N., Martin, L., 2005. The Çatalhöyük mammal remains. In: Hodder, I. (Ed.), *Inhabiting Çatalhöyük: Reports from the 1995–1999 Seasons*. McDonald Institute for Archaeological Research, Cambridge, pp. 35–95.
- Russell, N., Martin, L., Buitenhuis, H., 2005. Cattle domestication at Çatalhöyük revisited. *Curr. Anthropol.* 46 (S5), S101–S108. <https://doi.org/10.1086/497664>.
- Santana, J., Millard, A., Ibáñez-Estévez, J.J., Bocquentin, F., Nowell, G., Peterkin, J., Macpherson, C., Muñoz, J., Anton, M., Alrousan, M., Kafafi, Z., 2021. Multi-isotope evidence of population aggregation in the Natufian and scant migration during the early Neolithic of the Southern Levant. *Sci. Rep.* 11, 11857. <https://doi.org/10.1038/s41598-021-90795-2>.
- Sapir-Hen, L., Bar-Oz, G., Khalaili, H., Dayan, T., 2009. Gazelle exploitation in the early Neolithic site of Motza, Israel: the last of the gazelle hunters in the southern Levant. *J. Archaeol. Sci.* 36, 1538–1546. <https://doi.org/10.1016/j.jas.2009.03.015>.
- Schloeth, R., 1961. Das Sozialleben des Camargue-Rindes: qualitative und quantitative Untersuchungen über die sozialen Beziehungen – insbesondere die soziale Rangordnung – des halbwilden französischen Kampfrindes. *Z. Tierpsychol.* 18 (5), 574–627. <https://doi.org/10.1111/j.1439-0310.1961.tb00243.x>.
- Shackleton, D.M., Shank, C.C., 1984. A review of the social behavior of feral and wild sheep and goats. *J. Anim. Sci.* 58, 500–509. <https://doi.org/10.2527/jas1984.582500x>.
- Simoons, F.J., Baldwin, J.A., 1982. Breast-feeding of animals by women: its socio-cultural context and geographic occurrence. *Anthropos* 77, 421–448.
- Smith, P.E.L., 1990. Architectural innovation and experimentation at Ganj Dareh. *World Archaeol.* 21 (3), 323–335. <https://doi.org/10.1080/00438243.1990.9980111>.
- Smith, A., Oechsner, A., Rowley-Conwy, P., Moore, A.M.T., 2022. Epipalaeolithic animal tending to Neolithic herding at Abu Hureyra, Syria (12,800–7,800 calBP): deciphering dung spherulites. *PLoS One* 17 (9), e0272947.
- Speth, J.D., 2013. Thoughts about hunting: some things we know and some things we don't know. *Quat. Int.* 297, 176–185. <https://doi.org/10.1016/j.quaint.2012.12.005>.
- Starkovich, B.M., Stiner, M.C., 2009. Hallan Çemi Tepesi: high-ranked game exploitation alongside intensive seed processing at the Epipalaeolithic-Neolithic transition in southeastern Turkey. *Anthropozoologica* 44 (1), 41–61. <https://doi.org/10.5252/az2009n1a2>.
- Stiner, M.C., 1990. The use of mortality patterns in archaeological studies of hominid predatory adaptations. *J. Anthropol. Archaeol.* 9, 305–351. [https://doi.org/10.1016/0278-4165\(90\)90010-B](https://doi.org/10.1016/0278-4165(90)90010-B).
- Stiner, M.C., Buitenhuis, H., Duru, G., Kuhn, S.L., Mentzer, S.M., Munro, N.D., Pöllath, N., Quade, J., Tsartsidou, G., Özbaşaran, M., 2014. A forager-herder trade-off, from broad-spectrum hunting to sheep management at Aşıklı Höyük, Turkey. *Proceedings of the National Academy of Sciences of the United States of America* 111, 8404–8409. <https://doi.org/10.1073/pnas.1322723111>.
- Stiner, M.C., Munro, N.D., Buitenhuis, H., Duru, G., Özbaşaran, M., 2022a. An endemic pathway to sheep and goat domestication at Aşıklı Höyük (Central Anatolia, Turkey). *Proceedings of the National Academy of Sciences of the United States of America* 119 (4), e2110930119. <https://doi.org/10.1073/pnas.2110930119>.
- Stiner, M.C., Özbaşaran, M., Duru, G., 2022b. Aşıklı Höyük: the generative evolution of a Central Anatolian PPN settlement in regional context. *J. Archaeol. Res.* 30, 497–543. <https://doi.org/10.1007/s10814-021-09167-z>.
- Tsartsidou, G., 2018. The microscopic record of Aşıklı Höyük: phytolith analysis of material from the 2012–2016 field seasons. In: Özbaşaran, M., Duru, G., Stiner, M. (Eds.), *The Early Settlement at Aşıklı Höyük: Essays in Honor of Ufuk Esin*. Ege Yayınları, İstanbul, pp. 147–189.
- Twiss, K.C., 2012. The complexities of home cooking: public feasts and private meals inside the Çatalhöyük house. In: Pollock, S. (Ed.), *Between Feasts and Daily Meals. Towards an Archaeology of Commensal Spaces*. eTopoi. Journal for Ancient Studies special volume 2, 53–73.
- van Zeist, W., Smith, P.E.L., Palfenier-Vegter, R.M., Suwijn, M., Casparie, W.A., 1984. An archaeobotanical study of Ganj Dareh Tepe Iran. *Palaeohistoria* 26, 201–224.
- Vigne, J.-D., 2015. Early domestication and farming: what should we know or do for a better understanding? *Anthropozoologica* 50 (2), 123–150. <https://doi.org/10.5252/az2015n2a5>.
- Vigne, J.-D., Carrère, I., Briois, F., Guilaine, J., 2011. The early process of mammal domestication in the Near East: new evidence from the Pre-Neolithic and Pre-Pottery Neolithic in Cyprus. *Curr. Anthropol.* 52 (S4), S255–S271. <https://doi.org/10.1086/659306>.
- Watkins, T., 1990. The origins of house and home? *World Archaeol.* 21 (3), 336–347. <https://doi.org/10.1080/00438243.1990.9980112>.
- Watkins, T., 1992. The beginning of the Neolithic: searching for meaning in material culture change. *Paléorient* 18 (1), 63–75. <https://doi.org/10.3406/PALEO.1992.4563>.
- Weide, A., 2021. Towards a socio-economic model for southwest Asian cereal domestication. *Agronomy* 11, 2432. <https://doi.org/10.3390/agronomy11122432>.
- Wilkinson, P.F., 1972. Current experimental domestication and its relevance to prehistory. In: Higgs, E.S. (Ed.), *Papers in Economic Prehistory*. Cambridge University Press, London, pp. 107–118.
- Woodburn, J., 1982. Egalitarian Societies. *Man* 17 (3), 431–451. <https://doi.org/10.2307/2801707>.
- Wright, K.I., 2000. The social origins of cooking and dining in early villages of western Asia. *Proc. Prehist. Soc.* 66, 89–121. <https://doi.org/10.1017/S0079497X0000178X>.
- Wright, K.I., 2014. Domestication and inequality? Households, corporate groups and food processing tools at Neolithic Çatalhöyük. *J. Anthropol. Archaeol.* 33, 1–33. <https://doi.org/10.1016/j.jaa.2013.09.007>.
- Yeomans, L., Bangsgaard, P., Ahadi, G., 2023. Perinatal remains of livestock: an under-utilised line of evidence for animal penning in the Neolithic of Southwest Asia. *Environ. Archaeol.* 28, 207–221. <https://doi.org/10.1080/14641403.2021.1962497>.
- Zeder, M.A., 2001. A metrical analysis of a collection of modern goats (*Capra hircus* aegagrus and *C. h. hircus*) from Iran and Iraq: implications for the study of caprine domestication. *J. Archaeol. Sci.* 28, 61–79. <https://doi.org/10.1006/jasc.1999.0555>.
- Zeder, M.A., 2005. A view from the Zagros: new perspectives on livestock domestication in the Fertile Crescent. In: Vigne, J.-D., Peters, J., Helmer, D. (Eds.), *The First Steps of Animal Domestication: New Archaeozoological Approaches*. Oxbow, Oxford, pp. 125–146.
- Zeder, M.A., 2006. Reconciling rates of long bone fusion and tooth eruption and wear in sheep (*Ovis*) and goat (*Capra*). In: Ruscillo, D. (Ed.), *Recent Advances in Ageing and Sexing Animal Bones*. Oxbow Books, Oxford, pp. 87–118.
- Zeder, M.A., 2008. Animal domestication in the Zagros: an update and directions for future research. In: Vila, E., Gourichon, L., Buitenhuis, H., Choyke, A. (Eds.), *Archaeozoology of the Near East 8. Maison de l'Orient et de la Méditerranée*, Lyons, pp. 243–277.
- Zeder, M.A., 2011. The origins of agriculture in the Near East. *Curr. Anthropol.* 52 (S4), S221–S235. <https://doi.org/10.1086/659307>.
- Zeder, M.A., 2012. Pathways to animal domestication. In: Gepts, P., Famula, T.R., Bettinger, R.L., Brush, S.B., Damania, A.B., McGuire, P.E., Qualset, C.O. (Eds.), *Biodiversity in Agriculture: Domestication, Evolution, and Sustainability*. Cambridge University Press, Cambridge, pp. 227–259.
- Zeder, M.A., 2015. Core questions in domestication research. *Proceedings of the National Academy of Sciences of the United States of America* 112 (11), 3191–3198. <https://doi.org/10.1073/pnas.1501711112>.
- Zeder, M.A., Hesse, B., 2000. The initial domestication of goats (*Capra hircus*) in the Zagros Mountains 10,000 years ago. *Science* 287, 2254–2257. <https://doi.org/10.1126/science.287.5461.2254>.
- Zohary, D., Tchernov, E., Horwitz, L.K., 1998. The role of unconscious selection in the domestication of sheep and goats. *J. Zool. London* 245, 129–135. <https://doi.org/10.1111/J.1469-7998.1998.TB00082.X>.