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Pace and process in the emergence of animal husbandry in Neolithic Southwest Asia

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Abstract: *Discussions of animal domestication in Southwest Asia often describe a homogenous process in which sheep, goats, cattle and pigs were domesticated in relatively rapid succession producing a productive and integrated 'barnyard complex' which then helped fuel the rapid expansion of Neolithic farmers into neighboring regions. A critical examination of the data, however, suggests that the development of systems of animal husbandry took place over several millennia and followed markedly different trajectories in different regions within Southwest Asia and even at neighboring sites. In this paper I explore the development of the Neolithic 'barnyard complex' with an emphasis on its long gestation period, regional and local scale variability, and the importance of local context and histories in the construction of heterogeneous Neolithic animal economies.*

Key words: animal domestication; Southwest Asia; Neolithic; livestock

Animals in the Neolithic

Within accounts of the Neolithic Revolution, there is a tendency, especially within the secondary literature, to emphasize broad evolutionary patterns, to treat Southwest Asia as a homogeneous entity, and to equate Neolithic animal economies with those dominated by the 'barnyard complex' of domesticated sheep, goats, cattle and pigs (Banning 1998; Bellwood 2005; Cauvin 2000; Cunliffe 2008:88; Guilaine 2007). However, as recent research has brought the geographic and temporal patterns for the domestication of these animals into more detailed focus (Vigne et al. 2011; Zeder 2008b, 2011), it has become increasingly clear that this narrative is not accurate, and that the transition from hunting to husbandry was neither rapid nor homogenous across Southwest Asia (also see Asouti & Fuller 2012; Fuller et al. 2012). Neolithic animal economies in this region, far from being representations of homogenous evolutionary stages, instead, reflect a panoply of divergent responses to the complex local-scale requirements of task scheduling, gender politics, cosmologies, and social needs

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and preferences, features themselves defined by a combination of local histories, embedded within the limitations and opportunities provided by local environments.

In this paper, I present an overview of evidence for the origins of the four major domesticated food animals in Southwest Asia including sheep, goats, cattle and pigs. In the process, I explore several themes in the data including regional diversity in Neolithic animal economies, the importance of local histories and trajectories in the development of animal economies, and the relatively late development of the so-called 'barnyard complex' of domestic animals which is often taken to be synonymous with the term 'Neolithic economy'.

Zooarchaeology and animal domestication

Animal domestication is often described as a long-term process in which humans apply intensive, consistent and intentional control over animal populations resulting in significant changes in diet, mobility, breeding, and often phenotype (Bökönyi 1969; Ducos 1978; Meadow 1989). However, humans interact with animals in many different ways and there is no generally agreed upon boundary marking the beginning of a domestic relationship or the end of other types of relationships associated with hunting, commensalism, pet keeping, taming, and wildlife management (Russell 2010; Vigne et al. 2003, 2011; Zeder 2012b).

More intensive relationships often involve human control over the movement, feeding, and breeding of animal populations which can be identified in the archaeological record through slaughter profiles that target young males, isotopic evidence for foddering or other forms of dietary manipulation and the transport of animals outside of their natural habitat (Bökönyi 1969; Makarewicz & Tuross 2012; Zeder & Hesse 2000). Moreover, intensive management—by which I mean the significant, intentional and persistent manipulation by humans of an animal population's mobility, reproduction, and/or access to food and isolation from wild populations, often produces, over many generations, a series of behavioral and phenotypic changes in animals know collectively as the 'domestication syndrome' (Hammer 1984). Identifying features of this 'syndrome' including paedomorphic traits such as a reduction in brain and body size and foreshortening of the snout, as well as changes in horn morphology evident in many ungulates, has been a primary focus of archaeozoological studies of animal domestication (Hole et al. 1969).

However, it is clear that focusing on the appearance of 'morphological domesticates' provides a picture of a relatively late stage in the process of intensification in the relationship of human control over animal populations (Vigne et al. 2012). Recent approaches have emphasized that morphological changes and human management need to be treated as independent analytical units since they do not always covary, especially in the earlier stages of the domestication process and under less intensive

forms of management (Hadjikoumis 2012; Vigne et al. 2011; Zeder 2006). Instead, morphological changes can be expected to vary, not according to the presence or absence of human control, but rather depending on a constellation of issues including the intensity and type of management (i.e., free-range, herding, penning, etc), selective breeding, degree of inter-breeding with wild populations, and the genetic history of an animal population (e.g., feralization).

Figure 1. Map of Southwest Asia showing the location of sites mentioned in the text.

Since reconstructing management regimes is the ultimate goal of many domestication studies, recent approaches have put greater emphasis on contextualizing phenotypic changes using stable isotopes to identify human manipulation of diet and mobility and to use the age and sex composition of the slaughtered animal populations to differentiate strategies of intensive management, which tend to focus on culling young, surplus males, from those of hunting which often target large, adult males (Arbuckle & Atici 2013; Zeder & Hesse 2000). Through the analysis of a combination of demographic, biometric, isotopic, and paleogenetic datasets from a wide range of sites across Southwest Asia (see **Figure 1**) we can now attempt to reconstruct the increasingly complex story of the origins and development of systems of animal management in the Neolithic Near East.

Domestication of sheep and goats

Sheep

Sheep are widely regarded as one of the first domesticated livestock with genetic studies indicating that all domestic sheep (*Ovis aries*) derive from the Asiatic mouflon (*Ovis orientalis*) (Chessa et al. 2009). In the late Pleistocene wild sheep were hunted from the western Taurus mountains to the Zagros where, together with goats, they frequently represent 50-90% of archaeofaunal assemblages. Dating to the early tenth millennium and located in the northern Zagros, both Shanidar Cave (level B1) and the nearby open air site of Zawi Chemi Shanidar exhibit juvenile-focused culling patterns (c. 50% slaughtered before two years) which Perkins (1964) identified as the earliest evidence for intensive management. In a recent reanalysis of the assemblage, Zeder (2008a, 2011) has confirmed the young cull of the Zawi Chemi sheep but has linked this pattern to a broader shift in hunting strategies, also evident at the contemporaneous sites Hallan Çemi and Körtik Tepe, towards culling young individuals aged between 2-3 years (Arbuckle and Özkaya 2007; Redding 2005; Zeder 2012a).

It is likely that these sites, which exhibit round architecture suggesting a degree of sedentism, combined with a focus on phenotypically wild sheep (c. 50% NISP), represent an important shift towards increasingly varied and intensive interaction with, and management of, wild sheep populations. Although the specific types of human-animal relationships present at these tenth millennium cal BC sites remain unclear, given possible iconographic evidence for the use of nets for hunting sheep at the nearby site of Göbekli Tepe (Schmidt 2007:92), it is possible that animals were occasionally captured and kept in and around these early settlements in addition to being culled from free-ranging populations.

The early focus on sheep exploitation in the eastern portions of the upper Tigris drainage suggests that eastern Turkey/NE Iraq/NW Iran played an important role in developing increasingly intensive techniques for managing local wild mouflon populations (Meadows et al. 2007), although easy access to wild populations combined with small-scale and, perhaps, ephemeral approaches to management, render the earliest experiments difficult to identify. The difficulty of identifying management strategies in assemblages within the natural habitat zone is also evident at the ninth and eighth millennium cal BC site of Cafer Höyük, located in the highlands of the upper Euphrates. Here, Helmer (2008) has suggested that the herding of morphologically wild sheep co-existed alongside the continued hunting of mouflon. Although this combined hunting-herding exploitation strategy was most clearly identified in late eighth millennium deposits (phases I-IV), it is likely that it extends back to the earliest occupation of the settlement in the early ninth millennium (phases XXIII-IX)

indicating an early start to sheep management within a broad area of the Anti-Taurus and northern Zagros.

Clearer evidence for sheep management appears in the lowlands (outside of the region of intensive mouflon hunting) in the mid ninth millennium cal BC in south-eastern Turkey. In the earliest phases at Çayönü (Round and Grill phases), wild sheep, especially large rams, were occasionally hunted in the tenth and early ninth millennia (8% NISP) (Hongo et al. 2005). In the Channeled Building phases (8400-8200 cal BC) the appearance of smaller-sized sheep, combined with a culling bias in favor of adult females and a steady increase in sheep (c. 14%) in the following Cobble-paved phase (c. 8200-7600 cal BC) suggest that intensive, if small-scale, management was initiated at Çayönü by the mid to late ninth millennium.

These patterns are paralleled at Nevalı Çori, located within the valley of the Turkish Euphrates, where the culling of young, morphologically domestic sheep is argued to represent the emergence of herding as a small component of the economy (c. 5% NISP) as early as the mid to late 9th mill. cal BC (Peters et al. 2005). Moreover, isotopic evidence showing that the diet of small-sized livestock differed from morphologically wild counterparts suggests that managed sheep were foddered at Nevalı Çori (Grupe & Peters 2009; Losch et al. 2006). By 7500 cal BC morphologically domestic sheep increased in abundance and became the dominant (50-60% NISP) prey species along the Turkish Euphrates at sites including Gritille, Mezra-Teleilat, and Gürcütepe (Ilgezdi 2008; Monahan 2000; von den Driesch & Peters 2001).

Further south, along the Syrian Euphrates, where economies focused overwhelmingly on gazelle and Asiatic wild ass, mouflon hunting was a minor activity in the eleventh and tenth millennia cal BC (Ovis NISPs generally <5%) and adult rams were often preferentially targeted. At Mureybet, mouflon remain a minor component of the economy (c. 1% NISP) from the late Epipaleolithic (Mureybet 1A) through the early eighth millennium cal BC (IVB) (Gourichon & Helmer 2008). Morphological domesticates appear suddenly and in small numbers (c. 5% NISP) at nearby Abu Hureyra in the mid eighth millennium (level 2A), while clear evidence for culling young males and a massive increase in the frequency of sheep in level 2B (>50% NISP) indicates that herding increased dramatically in scale by 7300 BC (Legge & Rowley-Conwy 2000:467). Moreover, after their virtual absence from the first seven occupational levels at Halula, the rapid appearance of morphologically domestic sheep in Occupation Phase 8 confirms that domesticates were incorporated into animal economies, probably as imports, along the middle Euphrates c. 7500 cal BC (Sana Segui 2000).

In Central Anatolia, wild sheep were a small to moderate component of diverse 'broad spectrum' hunting economies on the Konya Plain as seen at Pinarbaşı and the settlement at Boncuklu dating to the ninth millennium (Baird 2012). However, to

the east, in Cappadocia, sheep were the focus of the animal economy at the village of Aşıklı Höyük (74% NISP, level 2) where morphologically wild animals were subject to a consistent cull focused on 2-4 year olds (Buitenhuis 1997); moreover, the presence of abundant perinatal remains as well as dung deposits indicate that animals were kept onsite perhaps as early as the late ninth millennium (Özbaşaran 2012). A limited range of variation in carbon and nitrogen stable isotope values from sheep teeth—a pattern also evident at contemporaneous Nevalı Çori—suggests that Aşıklı's herds were kept in restricted areas, rather than extensively herded (Meiggs 2010: Fig. 5.10; Pearson et al. 2007) perhaps suggesting that they were provisioned with fodder. Interestingly, this pattern of limited variation in diet has also been identified in the earliest levels at Çatalhöyük where morphologically domestic sheep are present by c. 7300 cal BC (Pearson et al. 2007). However, biometric data indicate that large males are well represented at Asıklı, suggesting that, like at Cafer, the hunting wild males continued alongside early management (Peters et al. 2013).

On the island of Cyprus, recent work has outlined a complex process of colonization in the late Epipaleolithic and early Neolithic that involved the transport of mainland taxa and has provided a paradigm-shifting window into the wide variety of human-animal relationships that existed at the Pleistocene-Holocene transition including commensalism, wildlife management, and intensive and extensive management systems (Vigne et al. 2003, 2011, 2012). At the site of Shillourokambos sheep were first imported in small numbers by the end of the ninth millennium cal BC (early A2) indicating that they were intensively manipulated and likely herded at this time—a chronology that places sheep management on Cyprus roughly contemporaneous with the emergence of herding on the southern Taurus flanks and perhaps Cappadocia (Aşıklı), but prior to its emergence on the northern Mesopotamian plains or southern Levant (Vigne et al. 2011). In the next phase (early B), dating to the first century of the eighth millennium, kill-off patterns show that young males were regularly culled suggesting an intensively managed population, although evidence for phenotypic change is largely absent.

Despite an early focus on sheep exploitation, mouflon hunting declines dramatically in the Zagros from the 10th to the 9th mill. cal BC (Zeder 2008a). Domestic sheep are abundant, although not the dominant taxon (35%), at Aceramic Jarmo (c. 7000 cal BC) (Stampfli 1983) but are absent further south and east where biometric data indicate that small numbers of morphologically wild mouflon, primarily adult rams, were hunted at Ganj Dareh (11% NISP), and at Ali Kosh (2-4% NISP) from the eighth through the beginning of the 7th millennium cal BC (Hesse 1978; Hole et al. 1969). Intensive sheep herding is first evident in the central Zagros region at Tepe Sarab and Choga Sefid, where young male kill-off and morphological domesticates indicate that herding was only adopted some time in the 7th mill. (Zeder 2008a).

The mouflon is not native to the southern Levant and appears to have been widely introduced as a domesticate in the mid eighth millennium cal BC (Horwitz et al. 1999). Perhaps unsurprisingly, sheep appear first in the northern portion of the southern Levant, in the Damascus basin, as seen at Tell Aswad. Here, sheep are largely absent from the small 'early' assemblage dating to the mid ninth millennium cal BC but appear in small but consistent numbers (c. 5% NISP) in the 'middle' and 'late' phases (late ninth-early eighth millennia) where demographic and biometric evidence suggest they were likely managed (Helmer & Gourichon 2008).

Further south, morphologically domestic sheep emerge at a variety of sites on the coastal plain and Jordan Valley in the mid eighth millennium. Sheep appear in small numbers in the PPNB levels at Jericho (2% NISP) and increase dramatically (from <1% to 31% NISP) at Ain Ghazal in LPPNB phases (7500 BC) becoming the dominant taxon at the site by the beginning of the seventh millennium cal BC (Clutton-Brock 1979; Wasse 2002). Domestic sheep exhibiting kill-off patterns focused on young individuals appear in southern Jordan at Basta and Baja by the late eighth millennia while sheep were introduced in the deserts of eastern Jordan by the early seventh millennium (Becker 1991; Horwitz et al. 1999; Martin 1999).

Goats

Genetic studies have shown that domestic goats (*Capra hircus*) are the descendants of the Asiatic bezoar (*Capra aegagrus*) (Luikart et al. 2001; Naderi 2007). Unlike mouflon, wild goats were heavily exploited in upland regions across the entire Fertile Crescent where there is evidence for increasingly intensive management in the ninth millennium cal BC in multiple regions.

An early emphasis on goat hunting has been identified in the southern and central Taurus (Arbuckle & Erek 2012; Atici 2011) and it extended south into Lebanon where Ksar Akil (c. 30% NISP) and Nachcharini (65% NISP) record systems of intensive bezoar exploitation dating from the Epipaleolithic through the tenth millennium cal BC (PPNA) (Garrard et al. 2003; Kersten 1989; Kuhn et al. 2009).

In southwestern Syria, bezoar hunting was a major component of the animal economy from the Younger Dryas into the eighth millennium cal BC (Helmer & Gourichon 2008; Ibanez et al. 2010). At Aswad, located some 20 kilometers from rugged bezoar habitat in the Damascus basin, morphologically wild goats are the most abundant taxon in the 'early' phase (52% NISP) dating to the mid to late ninth millennium cal BC. Although zooarchaeological evidence for management in this early phase is limited, it is likely that the abundance of goats in this lake basin environment reflects the intentional movement of goat populations onto the lowlands. In the 'middle' phase (late ninth millennium), a continued focus on goats (38% NISP), an emphasis on culling young males, as well as the appearance of torsion in male horncores pro-

vides the earliest evidence for intensive goat management in southwestern Asia. By the early eighth millennium, morphologically domestic goats were important components of economies at both Aswad (33%) and the nearby site of Ghoraife (42%) (Ducos 1993).

Further south, goats were a major focus of economies in the Jordan valley in the late ninth and early eighth millennia cal BC. At Jericho, goats increase dramatically from the late tenth millennium (PPNA) (3% NISP) to the ninth-eighth millennia (PPNB) where they represent 52% of the faunal assemblage (Clutton-Brock 1979). At Ain Ghazal, goats were also the dominant species (65% NISP) and a combination of young male cull and morphological changes including increased variation in horncore morphology and a decrease in body size suggest that goats were intensively managed in the early and middle eighth millennium (Wasse 2002).

In far southern Jordan, goats represent 90% of the fauna at the late ninth and early eighth millennia site of Beidha. Young male goats were heavily culled at Beidha suggesting intensive management (Hecker 1982), although the presence of large numbers of ibex (*Capra nubiana*), the remains of which are difficult to distinguish from goats (*Capra aegagrus*), complicate interpretations of some of the earliest evidence for goat management in the southern Levant. Remains from the site of Basta clearly indicate the presence of domestic goats in southern Jordan by the end of the eighth millennium cal BC. However, isotope evidence that goats at the site of Abu Gosh were foddered as early as 8000 cal BC suggests the intensive management of goats likely significantly preceded the appearance of morphological domesticates in this region (Makarewicz & Tuross 2012).

The Zagros was another center of early goat exploitation with bezoar heavily exploited at Shanidar Cave layer B (eleventh millennium), and at Asiab where they are the most abundant taxon (9000 cal BC). Both Bökönyi (1977) and Zeder (2008a) have argued that hunters at Asiab targeted adult males, while at Shanidar Cave, Perkins (1964) reports that 43% of the goats were culled as juveniles likely indicating that female-kid family groups were targeted.

The earliest clear signs of goat management in the Zagros are evident at Ganj Dareh where goats represent c. 88% of the fauna. Zeder and Hesse (2000) have identified a remarkably clear pattern of young male kill-off indicative of intensive management dated firmly to the beginning of the eighth millennium. A similar focus on managing domestic goats is also evident at eighth millennium Ali Kosh, on the Deh Luran plain, where Flannery documented changes in phenotype, including the shape of male horncores, associated with the 'domestication syndrome' (Hole et al. 1969).

In the central portions of the Fertile Crescent, goats were a minor component of the economy in the tenth millennium cal BC. In the Upper Tigris drainage, goats constitute less than 5% of the faunas from Hallan Çemi, Körtik Tepe and the Round

phase at Çayönü where adult males were occasionally hunted (Arbuckle & Özkaya 2007; Hongo et al. 2005; Starkovich & Stiner 2009). However, at Çayönü, goats slowly increase in abundance through the ninth millennium reaching 13% NISP in the Channel phase (c. 8300 cal BC)—a frequency maintained through the Pottery Neolithic. Consistent culling of young males and the appearance of some mild phenotypic changes (decrease in body size) are first evident in the late ninth millennium (Cobble phase) indicating the intensive management of small herds of goats was initiated by this time (Hongo et al. 2005).

Further north, at the highland site of Cafer, morphologically wild goats were the dominant taxon from the ninth through eighth millennium (42-35% NISP). By the mid eighth millennium (levels IV-I), Helmer (2008) has argued that morphologically wild goats were herded while at the same time free-ranging wild populations continued to be hunted.

In central Anatolia goats were not regularly exploited on the Konya plain in the ninth millennium as seen at Pinarbaşı and Boncuklu (Baird 2012; Carruthers 2005; Martin et al. 2002), but morphologically domestic goats make their appearance in the region in large numbers in the early levels of Çatalhöyük (c. 20% NISP) (Russell & Martin 2005). At Aşıklı, morphologically wild goats make up 13% of the assemblage in level 2 dating to the first half of the eighth millennium (Buitenhuis 1997). However, biometric and survivorship data and sex ratios show that older males were often targeted, a pattern frequently associated with hunting (Peters et al. 2013). As was perhaps the case at Cafer, it is likely that small scale herding and hunting were both practiced at Aşıklı in the early eighth millennium. Similarly, at the site of Suberde, contemporary with the early levels of Çatalhöyük, goats are abundant (17% NISP) but remain morphologically wild, indicating a significant degree of local variability in exploitation strategies across central Anatolia (Arbuckle 2008).

On the island of Cyprus, morphologically wild goats were imported as early as the mid ninth millennium as seen at Shillourokambos (early A1) (Vigne et al. 2011). Survivorship data indicate that culling focused on 2-4 year olds while biometrics indicate an unusual tri-modal pattern (Vigne et al. 2003: Fig. 3D) reflecting a large number of adult males not typically seen in early herding economies. Although clearly brought to the island by humans, Vigne (2011) has argued that goats were managed as wildlife in a manner similar to imported fallow deer. However, it seems likely that multiple goat management strategies were practiced on Cyprus perhaps recreating a local version of the combined herding and hunting systems present on the mainland (e.g., Cafer, Aşıklı).

Sites around the Turkish Euphrates exhibit a gradual increase in goats in the ninth and early eighth millennia. Goats are absent from Göbekli Tepe in the early ninth millennium but represent c. 5% of the fauna in the mid to late ninth millennium

levels at Nevalı Çori (I-II); goats increase to 11% in level IV, dated to the mid eighth millennium, which is comparable to contemporaneous levels at Gritille C-D (16%), Teleilat V (11%) and the slightly later deposits from Gürcütepe (13%) where morphological domesticates and the culling of young males indicates goats were intensively managed.

Further south, goats were not native to the steppic middle Euphrates basin and appear first at the site of Halula (OP1-3) (c. 7800 cal BC) where they represent a surprisingly large portion of the animal economy (c. 32-60% NISP) (Sana & Tornero 2008; Sana Segui 2000). Here, the culling of young males combined with some evidence for decrease in body size (Helmer 2008: Fig. 17) suggest the rapid emergence of goat herding. Goats appear slightly later and in smaller numbers (<10% NISP) in period 2A at Abu Hureyra (7500 BC) where biometric and demographic evidence for young male culling strongly suggest intensive management was practiced.

Cattle and pigs

Due to the small size and fragmentary nature of archaeofaunal samples the processes leading to the domestication of cattle and pigs have proven more difficult to reconstruct than for more abundant sheep and goats. As a result, previous work has often described cattle and pigs as later domesticates which were only brought under human management in the late eighth or seventh millennia (late PPNB and PN). Recent work, however, suggests that this was not the case, although, it is also clear that the spread of cattle and pig management within southwestern Asia followed dramatically different spatio-temporal trajectories than those for sheep and goats.

Cattle

Domestic taurine cattle (*Bos taurus*) derive from the aurochs (*Bos primigenius*) which were found in all but the most arid regions of southwestern Asia in the Pleistocene and early Holocene (Bradley et al. 1998; Uerpmann 1987). Both faunal and genetic research in the last decade point to the Syrian Euphrates and the upper Tigris as early centers of intensive cattle management with clear zooarchaeological evidence for intensive management appearing considerably later in neighboring regions (Bollongino et al. 2012; Helmer et al. 2005).

Aurochs were heavily hunted along the Syrian Euphrates at the site of Mureybet (Gourichon & Helmer 2008). Here, morphologically wild cattle make up c. 30% of the mammalian fauna in the ninth millennium (levels IVA and B) and 18% from nearby Jerf El-Ahmar. In addition, further north at Gobekli Tepe, aurochs represent the single largest contributor of animal products (18% of the NISP) (Peters et al. 2005).

The earliest evidence for morphological changes associated with intensive management has been identified in the early ninth century at Djade where Helmer and colleagues (2005) have shown a reduction in sexual dimorphism. A more dramatic decrease in body size is evident from the earliest layers at Halula dating to the early eighth millennium and also at mid eighth millennium deposits at both Teleilat and Gritille on the Turkish Euphrates (Ilgezdi 2008; Monahan 2000). Further north, Helmer (2008) has argued that a slight decrease in dimorphism (similar to the situation at Djade) and the presence of pathologies reflect cattle herding at Cafer (8300-7500 BC), although aurochs hunting is thought to have continued as well.

Along the upper Tigris, aurochs were heavily exploited in the tenth millennium at Çayönü (23% NISP Round phase) (Hongo et al. 2004) and they were also regularly hunted at contemporary Körtik Tepe (15% NISP) and at slightly later Nemrik 9 (36-48% NISP in phases IV and V) (Arbuckle & Özkaya 2007; Lasota-Moskalewska 1994). At Çayönü, changes in stable isotopes suggest increasing manipulation of the diet of cattle in the Channelled phase (c. 8300 BC) which, along with the appearance of gracile individuals, suggests increasingly intensive management of cattle was practiced in the late ninth millennium (Hongo et al. 2009).

Cattle were brought to the island of Cyprus in the late ninth millennium where they represent a small portion of the fauna (<5% NISP) from Shillourokambos (early A1-2) (Vigne et al. 2011). These early Cypriote cattle represent morphological domesticates and were subject to the preferential culling of young males (Vigne et al. 2003: Fig. 4). However, cattle are never represented in large numbers and decline dramatically after 7500 BC, eventually disappearing from the island.

Although phenotypically wild cattle were widely exploited in central Anatolia in the early Holocene, morphological changes are only evident in the mid to late seventh millennium (Twiss & Russell 2009). Aurochs are abundant at Boncuklu in the ninth and early eighth millennia while at Aşıklı, they represent 20% of the fauna from the offsite area P/R and are the most abundant taxon at the nearby site of Musular (c. 7500 BC) (Baird 2012; Russell et al. 2005). In the early phases at Çatalhöyük (7300-6500 BC) cattle continued to be a major economic and symbolic focus representing c. 20% of the mammalian fauna and 60-80% of the available meat yields (Russell & Martin 2005). Biometric data indicate a predominance of large males whose remains were often incorporated into commemorative deposits related to feasting events (Russell et al. 2009). However, by the mid seventh millennium this focus on large males is no longer evident with biometrics indicating a predominance of females and an increase in the culling of juvenile-subadult cattle (Russell et al. 2005). Moreover, morphologically domestic cattle exhibiting small body size and altered horncore morphologies appear suddenly at Çatalhöyük and also at Erbaba in the second half of the seventh millennium (Arbuckle & Makarewicz 2009; Rus-

sell 2011; Twiss & Russell 2009) suggesting that domesticates were imported from neighboring regions.

In the southern Levant, a combination of zooarchaeological data suggest that cattle were under human control at the site of Aswad in the late ninth and early eighth millennia (Helmer & Gourichon 2008). Further south, however, there is no clear evidence for intensive management of cattle until the seventh millennium when morphologically domestic cattle appear at sites on the coastal plain and Jordan Valley (Horwitz & Ducos 2005; Horwitz et al. 1999; Marom & Bar-Oz 2009). As was the case for the southern Levant, the management of domestic cattle appears late in the Zagros where biometric data from Tepe Sabz (Sabz phase) place the earliest domesticates perhaps as late as the sixth millennium on the Deh Luran plain (Hole et al. 1969).

Pigs

Domestic pigs derive from wild boar (*Sus scrofa*) whose wild range includes river valleys throughout southwestern Asia. Genetic studies addressing the complex history of pig husbandry indicate that the Near East was one of several early centers of pig domestication (Larson 2005). As non-ruminants omnivores, pigs differ dramatically from other livestock domesticated in the Neolithic in terms of diet, mobility, and environmental requirements. In contrast to the management of cattle, sheep and goats, pig management may take many forms representing a wide range of relationships between people and swine from intensive control characterized by stalling and foddering to extensive free-range management (Albarella et al. 2007; Hadjikoumis 2012). The flexibility of pig populations and their relationships with humans create major challenges to interpreting the history of pig management (Rowley-Conwy et al. 2012).

Suids were heavily exploited in the upper Tigris and Euphrates basins and on the island of Cyprus in the early Neolithic. Recent research indicates that boar were transported to Cyprus in the late Pleistocene where they were the primary target of hunting parties in the eleventh through ninth millennia (Vigne et al. 2012; Vigne et al. 2009). Despite this early evidence for the manipulation of boar populations, Vigne has argued that intensive pig husbandry on Cyprus is evident only in the early-mid eighth millennium (Vigne et al. 2011).

Along the upper Tigris drainage pigs were heavily exploited at both Hallan Çemi and Çayönü. At Hallan Çemi pigs were the dominant taxon in the early tenth millennium with close to 40% culled as juveniles in the uppermost layers (Rosenberg et al. 1998; Starkovich & Stiner 2009). However, no morphological changes are evident suggesting that pig exploitation strategies at Hallan Çemi did not involve reproductive isolation and are perhaps most consistent with hunting practices (Starkovich & Stiner 2009).

In the tenth and ninth millennia (Round and Grill phases) at Çayönü large-sized boar were also the dominant taxon (c. 50% NISP) and adults were primary targets (Hongo et al. 2004). In the late ninth and early eighth millennia (Channelled phase) phenotypic changes are increasingly evident. Size decrease as well as juvenile kill-off become more pronounced in the mid to late eighth millennium indicating a well developed system of swine management (Ervynck et al. 2001).

In the Euphrates basin, the site of Nevalı Çori presents some of the earliest evidence for pig management. Although initially a small component of the economy, by NÇ IV (c. 7500 BC), an increase in pigs (to almost 20% NISP) combined with the appearance of small-sized individuals with isotope values interpreted as indicating foddering (Grupe & Peters 2011; Losch et al. 2006) suggest population isolation and intensive management, a pattern clearly evident from more dramatic phenotypic changes at the slightly later site of Gürcütepe (20% NISP) (Peters et al. 2005). This chronology corresponds broadly with the appearance of morphologically domestic pigs on the Turkish and Syrian Euphrates in the mid eighth millennium (Peters et al. 2005).

At Cafer Hoyuk, pigs increase through the ninth and eighth millennia from 5% NISP to 28% in the 'phase recente' (Helmer 2008). By the final phase at Cafer (I-IV), more than 90% of pigs were slaughtered before one year strongly indicating intensive management by the mid eighth millennium. However, the Cafer pigs retain the phenotype of local wild boar suggesting that, as was the case at Çayönü, there was a low degree of population isolation between wild and managed populations in river valley communities where boar were abundant.

Finally, early evidence for pig management comes from the northern margin of the southern Levant at Tell Aswad. Small-sized pigs are present at Aswad along with larger wild boar in the late ninth millennium (moyen phase). In the 'recent' phase (7500 BC) these smaller-sized individuals were slaughtered at younger ages than the larger individuals strongly suggesting that they represent an intensively managed population (Helmer & Gourichon 2008). However, pig management did not extend south of the Damascus basin into the southern Levant in the eighth millennium. Further south, pig management was only initiated in the seventh and sixth millennia (PPNC, PN) as seen at Atlit Yam, Hagoshrim and also at Ras Shamra in Lebanon (Haber & Dayan 2004; Helmer 1994; Horwitz et al. 1999). This pattern is repeated in the Zagros and Central Anatolia where boar are rare in faunal assemblages and morphological domesticates are not widespread until the sixth and fifth millennia respectively (Arbuckle forthcoming; Flannery 1983; Martin et al. 2002; Price & Arbuckle 2013; Zeder 2008b).

Discussion

The picture of animal domestication described here diverges from the general narrative of the Neolithic Revolution in several important ways. First, despite the fact that domestic sheep, goats, cattle and pigs are often described as characteristic features of Neolithic economies of Southwest Asia it is clear that this 'barnyard complex' developed slowly over a period of several millennia and that it did so, not from a single 'core', but instead within a rather large area.

There are only five sites where it is fairly certain that the full suite of domestic livestock were managed together by 8000 cal BC. Including Tell Aswad, Çayönü, Nevalı Çori, and Shillourokambos, these sites represent a geographic area extending from the upper Tigris west to the upper and middle Euphrates, the island of Cyprus, and south to the Damascus basin. For most of Southwest Asia, however, the barnyard complex did not come together until the Pottery Neolithic (seventh millennium cal BC) and in some regions it was not until the Chalcolithic that cattle and pigs were combined with caprine husbandry into fully integrated livestock economies (Arbuckle 2013; Haber & Dayan 2004; Hole et al. 1969; Price & Arbuckle 2013). The fact that this zone of early animal management is spread over a considerable geographic area suggests the development of parallel trajectories of animal management occurring within this broad expanse of inter-communicating communities rather than the emergence and spread of domesticates from a single "cradle" (Dietrich et al. 2012; Peters et al. 2005).

In addition, instead of representing a homogenous system, Neolithic animal economies are characterized by a high degree of variation linked to a combination of local environmental conditions and historically derived cultural preferences (Conolly et al. 2011; Peters et al. 2013). This variation is evident in both the tempo of the development of herding economies and in the choices of which taxa were incorporated into systems of animal management. For example, in the tenth and ninth millennia cal BC, goats were heavily exploited in the highlands of Lebanon and western Syria and in the Jordan Valley, while in the Negev ibex were the target of intensive hunting. Along the upper Tigris at Çayönü the animal economy was structured around the intensive exploitation of pigs and deer while further east at Hallan Çemi it was sheep and pigs, and at Körtik Tepe a combination of sheep and deer were hunted. Pigs were an important part of the economy at Cafer in the upper Euphrates basin although they were combined with large numbers of goats and sheep and on Cyprus pigs and deer were the preferred taxa. In the Zagros early Holocene economies focused on deer and goats while in Central Anatolia sheep, pigs and cattle were targeted. At the same time, gazelle exploitation dominated in the semi-arid steppic belt extending from the coastal plain of the southern Levant to the Turkish Euphrates and the Zagros piedmont, although, along portions of the Syrian Euphrates Asiatic wild ass was the dominant prey.

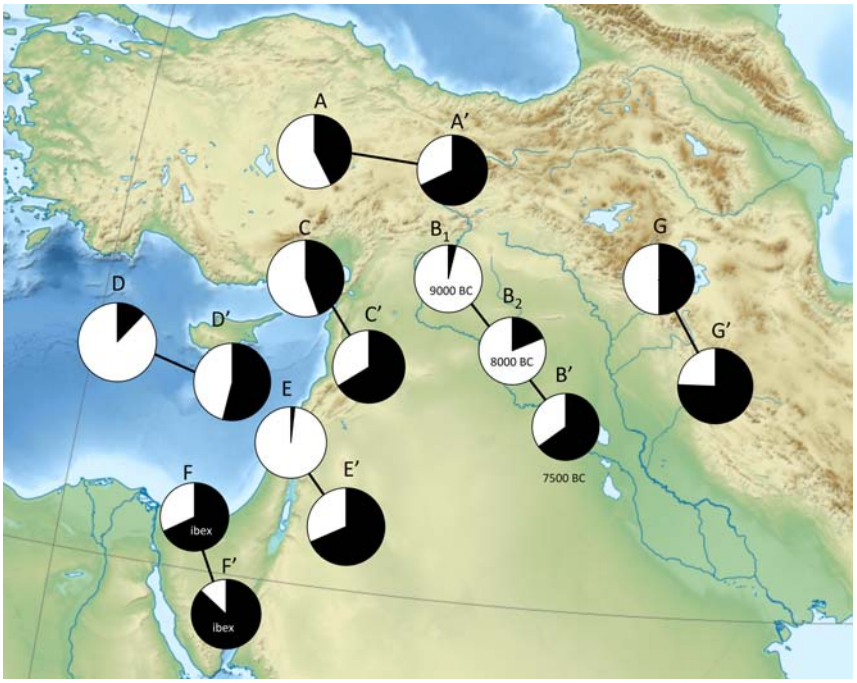

Figure 2. Changes in the frequencies of sheep/goat (black portion of pie charts) versus other mammalian taxa (white portion) in Neolithic archaeofaunal assemblages (A-G) before 7500 cal BC and (A'-G') after 7500 cal BC in seven regions of Southwest Asia. Sites included: Group A (upland northern Mesopotamia/central Anatolia) = Hallan Çemi, Körtik, Çayönü, Pinarbası, Direkli, Boncuklu, Asıklı, Suberde, Erbaba, Çatalhöyük, Bademagacı, Cafer; Group B (lowland northern Mesopotamia) = Göbekli, Abu Hureyra, Mureybet, Jerf El Ahmar, Djade, Cheikh Hasan, Nahr El Homr, Mlefaat, Qermez Dere, Nevalı Çori, Halula, Gürcütepe, Gritille, Teleilat, Tell Assouad, Um El Tlel, El Kowm 2, Feysa, Kashkashok; Group C (western Syria/Lebanon) = Ksar Akil, Üçagızlı, Jebel as Saaide II, Nachcharini, Aswad, Ghoraife, Ramad; Group D (Cyprus) = Aetokremnos, Klimonas, Shillourokambos, Khirikitia; Group E (southern Levant) = Hayonim, Mallaha, Nahal Oren, Neve David, Hatoula, El Wad, Hilazon Tachtit, Netiv Hagdud, Jericho, Gilgal, Motza, Yiftahel, Tifdan, Beisamoun, Ain Jamman, Ain Ghazal, Ashkelon; Group F (Sinai/Negev) = Wadi Judayid, Rosh Horesha, Wadi Mataha, Beidha, El Khiam, Abu Salem, Wadi Faynan, Wadi Tbeik, Ujrat El-Mehed, Basta; Group G (Zagros) = Palegawra, Warwasi, ZC Shanidar, Karim Shahir, Ghar-i-Khar, Asiab, Shanidar, Ganj Dareh, Jarmo, Sarab, Hai Firuz, Tepe Guran, Ali Kosh.

The picture here is overwhelmingly one of unique animal economies developing out of local hunting and wildlife management traditions. These local hunting traditions had a clear impact structuring which domesticates were incorporated into local economies and when. In the upland regions where mouflon were heavily exploited in the tenth and ninth millennia cal BC (eastern upper Tigris and central Anatolia) preferences for domesticated sheep continued into later periods, while in regions with

traditions of intensive bezoar hunting (Lebanon, western Syria, Jordan Valley, Zagros) domesticated goats appear early as the preferred taxon and sheep were incorporated a millennium or more later (**Figure 2**). Likewise in areas where wild boar were regularly hunted, including the upper Tigris and Euphrates, Damascus basin and Cyprus, pig management is evident from an early date. However, traditions of swineherding were very slow to develop in most other regions and it was not until the Chalcolithic that domestic pigs were widespread in central Anatolia, the southern Levant, and the Zagros. Similarly, traditions of aurochs hunting in the middle Euphrates region evolved into early systems of management in the ninth millennium (Bollongino et al. 2012). Cattle management, however, did not take hold in the southern Levant, central Anatolia or the Zagros for another two millennia.

Intimately related to the slow development and initial diversity of Neolithic animal economies is the fact that managed animal populations were initially very small components of subsistence systems especially in the ninth and early eighth millennia cal BC. This is especially clear in regions of the Fertile Crescent dominated by traditions of gazelle hunting where at Aswad, Nevalı Çori, Jericho and Abu Hureyra 2 domestic sheep and goats initially appear in small numbers and clearly contributed relatively little to the diet. This is also the case at Çayönü where the frequencies of domesticated animals increase slowly throughout the Neolithic sequence suggesting that initial forays into herding were driven by the social rather than economic value conferred by managed animals (Russell 2012).

Why then did it take such a long time for domestic animals to become the focus of animal economies? Part of the answer probably lies in the difficulties inherent in incorporating the labor-intensive and resource expensive processes of animal husbandry (including foddering, herding, stabling) into pre-existing task schedules (Ingold 1993). Initiating animal management would have involved redirecting labor towards herding and building shelters and pens and the collection of fodder and thus would have initially been an expensive process not attractive to most social groups. Moreover, early herders would have faced a host of technical problems maintaining healthy animals including zoonoses, losses to predators, and problems associated with inbreeding resulting from small herds especially in social environments with few partners to exchange breeding stock. The ultimate failure of Neolithic cattle herding on Cyprus highlights the technical difficulties faced by early herders in maintaining small herds especially in regions with limited access to new stock (Vigne et al. 2003).

In addition, in communities such as those of early Neolithic SW Asia, where productive plant-based economies probably provided the bulk of calories, large game hunting is often secondary in terms of its contribution to the diet but plays a disproportionate social role, especially among men (Hildebdrandt & McGuire 2002; Speth 2010). It is likely that hunting and its social *châine opératoire* were deeply embedded

within the ritual and cosmological structure of early Neolithic communities, as suggested by the widespread presence of wild animal iconography and symbolism in the Neolithic (Goring-Morris & Horwitz 2007; Helmer et al. 2004; Hodder & Meskell 2011; Peters & Schmidt 2004; Twiss & Russell 2009; Twiss 2006). Hunting was therefore not easily displaced by herding, a process which would have required complex renegotiations of long-standing power structures and disruptions of daily practices within individual communities. The complications resulting from these dual processes of social and technological change likely played a central role in the slow development of livestock economies evident in the fauna record.

A full millennium after the initial emergence of systems of small-scale management of the four major domesticates, a major shift is evident in the development of herding economies across Southwest Asia involving the spread of intensive and large-scale caprine herding in the mid and later eighth millennium (**Figure 2**) (Late and Final PPNB) (Arbuckle 2012; Davis 1987). This reorganization of animal economies is especially apparent in the spread of sheep management into regions with little or no tradition of mouflon hunting (e.g., southern Levant, Zagros, Cyprus), a rapid increase in sheep remains in assemblages across much of the region as well as clear evidence for managed culling of young males and the widespread appearance of morphological domesticates (**Figure 3**) (Arbuckle & Atici 2013; Horwitz et al. 1999; Zeder 2008a, b).

It is at this point in the mid eighth millennium cal BC that the social role of hunting seems to have been eclipsed by herding, the productivity of which seems to have increased dramatically perhaps as a result of increased technical competence and the availability of large, regional populations of domestic stock. Kill-off patterns suggest efficient management of herds with the culling of surplus young males widely practiced (Arbuckle & Atici 2013), while the presence of dung deposits at multiple sites suggests that animals were regularly penned (Brochier 1993; Matthews 1998, 2005; Özbaşaran 2012); moreover, evidence from the site of Teleilat indicates that caprines were at least occasionally kept within structures for milking and perhaps for birthing (Ilgezdi 2008) (**Figure 3**).

This increased emphasis on sheep and goat herding in the mid eighth millennium cal BC represents the articulated, parallel responses of many communities to an increase in the technical competence of herding systems, the social acceptance of practices associated with herding domestic animals, and the ability of communities to share and exchange livestock and herding knowledge within social networks. These changes made herding, for the first time, both a reliable and desirable activity resulting in many communities rapidly increasing their own use of domestic animals—a change in diet reflected by isotopic evidence for the increased consumption of animal protein at Late PPNB Gürcütepe (Losch et al. 2006). However, this shift was largely limited to caprine herding and it was still more than a millennium before cattle

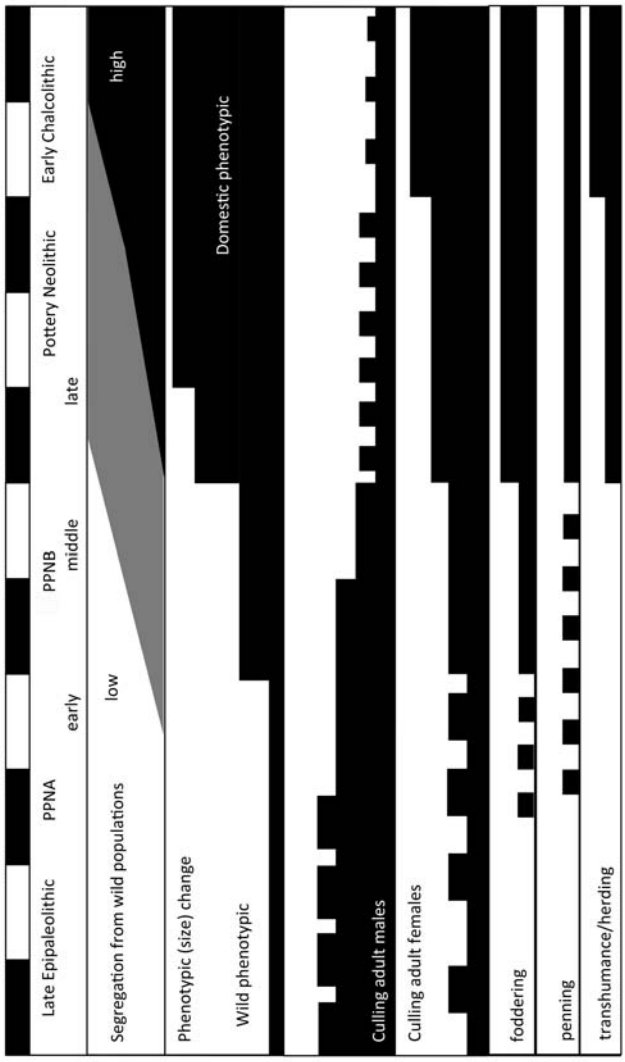

Figure 3. Model of gradual changes in animal management strategies through the Neolithic in Southwest Asia leading from hunting to livestock husbandry (based on Arbuckle & Atici 2013; Brochier 1993; Helmer & Gourichon 2008; Hongo et al. 2009; Ilgezdi 2008; Losch et al 2006; Makarewicz & Tuross 2012; Peters et al. 2013; Vigne et al. 2012; Zeder 2011). Dates are relevant primarily for sheep and goats although general trajectories also pertain to cattle and pigs.

and pig husbandry were widely incorporated into the pastoral economies developing across Southwest Asia.

Conclusion

In this paper, I have attempted to summarize evidence for the origins of animal management in Neolithic Southwest Asia. Together, current evidence suggests that increasingly intensive management of local populations of sheep, goat, cattle and boar extends back into the early ninth millennium cal BC within a broad arc extending from the coastal northern Levant (including Cyprus) through the Anti-Taurus foothills and into the Northwest Zagros. However, variation in the frequency of taxa and in evidence for management strategies suggests that early husbandry systems were highly localized and diverse and they appear to be the result of fundamentally local (although not isolated) processes which were structured by site-specific histories and preferences. This observation parallels the emerging consensus on the development of Neolithic plant economies which emphasizes the fundamentally local nature of Neolithic subsistence systems and their sensitivity to both local environments as well as local cultural preferences and traditions (Asouti & Fuller 2012, 2013; Fuller et al. 2012; Weiss & Zohary 2011).

This variation in early animal economies persists for several millennia and indicates that the social and technological processes involved in the development of domestic livestock and appropriate methods for their husbandry as well as a transition away from large game hunting were complex and rather challenging. Thus, despite the fact that the term 'Neolithic economy' is often used as shorthand for a system that includes the 'barnyard complex' of domestic sheep, goat, cattle and pig, it is clear from the archaeozoological data that this package of domestic animals was in fact the exception rather than the rule for most of the Neolithic of Southwest Asia. Despite the early appearance of domesticates in the ninth millennium cal BC, on a regional scale, it is not until the sixth or even fifth millennium cal BC that all four domestic taxa were finally incorporated into subsistence systems across the entire arc of the Fertile Crescent and Central Anatolia. These broad patterns of localization, variation, and the generally slow pace of change suggest that Neolithic animal economies were fundamentally conservative with roots extending back into local hunting traditions. In order to make sense of these varied local trajectories we need to focus more attention on the social processes involved in transitioning from hunting to herding and from caprine herding to mixed herding incorporating domestic bovids and suids. Although it is clear that subsistence practices are closely articulated with a host of social structures including division of labor, gender identities, marriage practices, inter-group violence, and cosmology these relationships are only just beginning to be explored in

the Neolithic and offer a fascinating opportunity to contextualize the social processes that lay behind the economic patterns emerging in the archaeozoological record.

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