‘Garden agriculture’ and the nature of early farming in Europe and the Near East

Amy Bogaard

Abstract

This paper takes a comparative approach to early farming, arguing that bioarchaeological work on Neolithic Europe can inform understanding of earlier cultivation and herding in the Near East, where the ‘package’ of crops and livestock emerged in the PPNB period. Evidence for intensive cultivation (‘garden agriculture’) integrated with small-scale herding is outlined for south-east and central Europe before turning to crop and caprine husbandry practices during the PPNB. It is concluded that integration of small-scale cultivation and herding during the PPNB facilitated the spread of agriculture to Europe.

Keywords

Neolithic; south-east Europe; central Europe; Near East; crop husbandry; animal husbandry

Introduction

A desire to pinpoint the precise origins of agriculture in the Near East has led to an emphasis on the *recognition* of early cultivation or herding and of morphological changes indicative of domestication. Rather less attention has been paid to the *practice* of early farming once domesticated crops (especially the cereals and pulses) and livestock (sheep, goat, pig, cattle) had emerged. Discussion of Neolithic cultivation and herding practices in Europe, by contrast, has generated a wide range of models as well as debate over the social implications of the agricultural transition (e.g. Childe 1957; Sherratt 1980; Rowley-Conwy 1981; Barker 1985; Bogucki 1988; Halstead 1989a; Whittle 1996; Thomas 1999; Lüning 2000; Bogaard 2004a, b). Key issues include the mobility of Neolithic cultivators, the scale of herding and its integration with arable farming, the relative dietary importance of crops and livestock, the labour-intensity of cultivation and the gradual or sudden/traumatic course of indigenous acculturation to a ‘Neolithic’ lifestyle.

Routledge
Taylor & Francis Group

World Archaeology Vol. 37(2): 177–196 *Garden Agriculture*

ISSN 0043-8243 print/1470-1375 online
DOI: 10.1080/00438240500094572

The central thesis of this paper is that recent modelling of Neolithic farming in the European context can usefully inform discussion of early cultivation and herding practices in the Near East, where the search for 'origins' has overshadowed investigation into the nature of early farming *systems* (cf. Harris 2002). The approach taken here is to consider first the European evidence for Neolithic crop and livestock husbandry practices before turning to bioarchaeological evidence for the Pre-Pottery Neolithic B (PPNB) (*c*. 8800–6250 cal. BC) (Table 1) in the Near East, when both cultivation and herding were established and became widespread. The goal is to draw attention to certain recurring features of early farming regimes that, it will be argued, were fundamental to the emergence and resilience of the farming household as an economically viable and socially creative entity. Functional interdependence between small-scale crop and animal husbandry practices is key to understanding early farming and broader changes in society, especially increasing household autonomy (cf. Flannery 1969, 1972, 2002; Byrd 2000). The spread of Near Eastern domesticates as suites or packages across Europe has been interpreted from the point of view of consumption and trade (Runnels and van Andel 1988; Sherratt 1999), but equally critical is the way in which suites of crops and livestock interact within the system of production.

Functional interdependence between early crop and livestock husbandry in the Near East and Europe has generally been obscured by the following models/assumptions:

1. 'Least effort' models, which assume that early farmers merely exploited the natural fertility of newly cleared forest soil (as in shifting cultivation) or seasonally flooded alluvium (as in floodplain cultivation), owe more to general narratives of progressive intensification (e.g. Boserup 1965) than to archaeological evidence (see Fairbairn this volume; Jones this volume). If applied to cultivation and herding, the labour intensity witnessed by frequent re-plastering and cleaning of PPNB houses in the Near East, or construction and replacement of timber longhouses in central Europe, would admit higher labour inputs and more careful management than is often assumed.
2. Manuring has been seen as a relatively late innovation forming part of the 'secondary products revolution' (e.g. Bakels 1997) but there is no reason to assume that the benefits of manuring were not appreciated and exploited by early farmers

Table 1 Simplified chronology of the Near East, Late Epipaleolithic–Pre-Pottery Neolithic (after Cauvin 2000; Wright 2000)

*Period**	*Dates cal. BC*
Natufian	12500–9500
PPNA	9500–8600
Early PPNB	8600–8200
Middle PPNB	8200–7500
Late PPNB	7500–7000
Final PPNB (or PPNC)	7000–6300

*these period terms, developed in the Levant, are applied here as convenient chronological labels to sites across the Fertile Crescent

(cf. Jarman et al. 1982: 142), particularly if early cultivation and herding practices are viewed from the perspective of new social demands on household production (Bender 1978; Hayden 1990).

3. A number of authors (e.g. Köhler-Rollefson 1992; Ducos 1993, 1994; Wasse 1997) have extrapolated the traditional divorce between (nomadic) pastoralism and (sedentary) arable farming in the Near East back to the Neolithic. The association between full-time specialized pastoralism and state-level socio-political complexity, however, suggests that this uniformitarian assumption is inappropriate for much of prehistory (e.g. Halstead 1987; Russell 1988: 152).

The intensive mixed farming model

The terms 'intensive' or 'garden' cultivation are used to indicate relatively high labour inputs/unit area, and hence a restricted scale of cultivation; 'extensive' cultivation, by contrast, involves larger areas of land with less frequent cropping (e.g. shifting cultivation) and/or less careful management (e.g. extensive cultivation with the ox-drawn ard). 'Intensive herding' indicates high labour inputs for a relatively small number of animals kept close to the settlement, as opposed to 'extensive' management of large herds over considerable distances. Forms of cultivation that do not require inputs from herds (e.g. manure) are compatible with large-scale mobile herding, while intensive garden cultivation is suited to small-scale herding. Table 2 summarizes models of crop and livestock husbandry for Neolithic Europe (see also Bogaard 2004a, b).

'Intensive mixed farming' refers to intensive cultivation integrated with intensive livestock herding (Table 3). Crop cultivation in this system is relatively high-yielding due to high inputs of labour (careful tillage, weeding, manuring, watering, etc.) and is small-scale, within the labour capacity of a household. Animals are primarily kept for their meat, though milk and wool/hair may also be used. This 'multi-purpose' exploitation of livestock may include unspecialized traction animals, such as cows, reducing human labour requirements without significantly increasing cultivation scale. Cultivation provides forage and fodder for livestock, while livestock provide manure for cultivated plots and regulate crop growth (Table 3).

Small-scale intensive farming appears better suited to nuclear households than to extended family groups, which tend to be associated with the need for adults to carry out incompatible tasks (e.g. childcare, tending of distant fields, long-distance herding) (cf.

Table 2 Simplified summary of crop and animal husbandry models for Neolithic Europe, showing links between animal and crop management (after Bogaard 2004b: table 1)

Animal husbandry models	*Crop husbandry models*
Extensive herding	Shifting cultivation Extensive ard cultivation Floodplain cultivation
Intensive herding	Intensive garden cultivation

Table 3 Functional interdependence between crop and animal husbandry in intensive mixed farming (after Bogaard 2004b: table 2)

Animal contribution to crop husbandry	*Crop contribution to animal husbandry*
Manure to fertilize the soil, from grazing animals or from spreading of collected manure	Crop by-products and products (spoiled or surplus) used as fodder
Grazing of unripe crops to prevent lodging and promote tillering	Cultivation plots provide grazing

Byrd 2000; Flannery 2002). Careful management of small plots close to home is compatible with childcare and the use of child labour, while small-scale herding minimizes overnight stays outside the home. The motivation to increase household productivity through high labour inputs is consistent with evidence that small-scale households formed an important socio-economic unit in society even before farming was established (Bogucki 1999: 193–5; Byrd 2000; Goring-Morris and Belfer-Cohen 2003). Intensification would draw on cooperative effort within households and deployment of the household's own 'fund of ecological information' (Netting 1990: 40).

Netting (1971, 1990), Forbes (1982) and Halstead (1981, 1987, 1989b) have explored the adaptive advantages of small-scale, intensive husbandry in recent farming societies (e.g. for managing the risks associated with domestic production), as well as its socio-political significance (e.g. potential to accumulate/deploy small-scale surplus resulting from inherent overproduction). The concept of 'transegalitarian' societies as developed by Hayden (1990, 1995) provides a theoretical framework in which households may invest high amounts of labour to compete with other households (*contra* 'least effort' models).

Crop and animal husbandry in Neolithic Europe

The following sections briefly review available evidence for herding and cultivation regimes with particular reference to three adjacent regions of south-east and central Europe – Greece and the southern Balkans; the Great Hungarian Plain; and the western loess belt and Alpine Foreland (Fig. 1).

Animal husbandry

Evidence for intensive herding in Neolithic Greece (seventh–fourth millennium BC) includes the predominance of sheep (associated with open vegetation) in faunal assemblages, mortality evidence that sheep were exploited for meat (and not intensively for dairy products) and decreasing domestic pig and cattle size (indicating a lack of interbreeding with wild herds, contrary to expectations for extensive herding) (Halstead 1981, 1996a, 1996b, 2000, in press). Halstead argues that unfeasibly large herds would be needed to support Greek tell villages and concludes that cereals and pulses provided the mainstay of the diet, though livestock offered a vital 'back up' in times of crop failure and played an important social role in communal feasting. Recent work on Neolithic

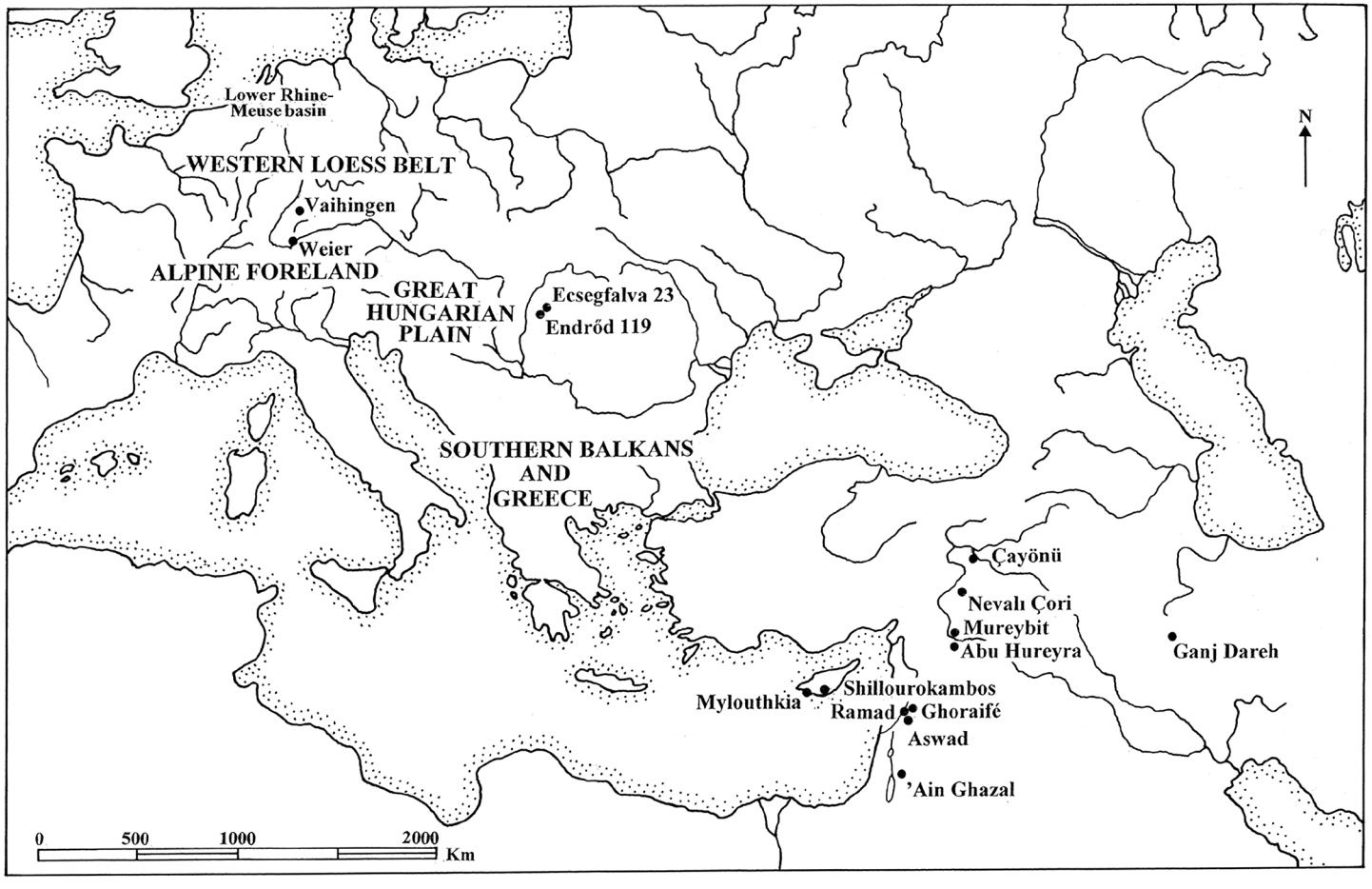

Figure 1 Map showing the regions and sites mentioned in the text.

archaeobotanical assemblages from northern Greece (Valamoti and Jones 2003; Valamoti 2004) includes evidence for the use of animal dung as fuel – consistent with the keeping of small herds near the settlement – and possible feeding of crop material to livestock.

As more and larger faunal assemblages of the Körös culture (*c*. 6000–5500 BC) in south-east Hungary become available, the clear predominance of domesticated livestock (especially sheep and goat) over wild fauna is apparent (Bökönyi 1992; Bartosiewicz in press). Caprine culling patterns at the Körös sites of Endröd 119 (Bökönyi 1992) and Ecsegfalva 23 (Bartosiewicz pers comm., in press; Pike-Tay in press) point towards generalized/meat-oriented management. The detection of dairy fat residues on potsherds from Ecsegfalva 23 (Craig et al. in press) is consistent with a generalized herding strategy in which livestock were exploited for a range of products. Dental micro-wear analysis of sheep and goat mandibles from Ecsegfalva 23 (Mainland in press) suggests high soil ingestion and over-grazing in penned areas, implying small-scale and intensive herd management.

The available evidence for livestock management practices of the *Linearbandkeramik* (LBK, *c*. 5500–5000 BC) in the western loess belt again suggests small-scale, intensive management: the metrical data argue against regular interbreeding between domesticated and wild cattle or pigs (e.g. Benecke 1994: 48–55; Lüning 2000: 105) and the mortality data appear to reflect meat production (e.g. Arbogast 1994: 93; Benecke 1994: 95).

Mortality evidence for (cattle) dairying emerges in the later Neolithic lakeshore settlements of the Alpine Foreland (*c*. 4300–2400 BC). The lack of permanent pasture and need for winter fodder, however, would have limited the scale of herding (e.g. Gross et al. 1990; Hüster-Plogmann and Schibler 1997). Archaeobotanical analysis of waterlogged animal dung from lakeshore sites (e.g. Robinson and Rasmussen 1989; Rasmussen 1993; Akeret and Jacomet 1997; Akeret et al. 1999) has revealed a variety of feeding practices, including twig/branch and crop fodder. At Weier, archaeobotanical and entomological studies have documented stalling of livestock and manuring of an arable plot close to the settlement (Robinson and Rasmussen 1989; Overgaard Nielsen et al. 2000). It should be emphasized that such evidence first appears under waterlogged conditions and would not be preserved in earlier 'dryland' sites.

Crop husbandry

The lack of evidence for extensive woodland clearance in Greek pollen sequences, or of faunal evidence for ox traction, suggests that cultivation was small-scale (Halstead 1981, 1996a, 1996b, 2000, in press). Furthermore, Neolithic sites in Greece have yielded evidence for a diversity of pulse crops, associated with garden-like growing conditions (Halstead 1981, 1996a, 1006b, 2000, in press), though there is as yet little archaeobotanical evidence for Neolithic arable weed floras in Greece (see Valamoti 2004). In southern Bulgaria, work by Marinova (2001) on weeds associated with charred crops (including stores) at several Neolithic tell sites reveals floristic overlap with potential weed assemblages in central Europe, where intensive cultivation is indicated by statistical and ecological analysis of arable weed assemblages (see below).

Archaeobotanical data from Körös sites in the Hungarian Plain are few, but ecological analysis of the arable weed assemblage from Ecsegfalva 23 (Bogaard et al. in

press a, in press b) indicates intensive management of permanent plots rather than shifting cultivation. High dry ground in the vicinity was more than sufficient for small-scale cultivation; household labour was probably a more important limiting factor than seasonal flooding. Though more work is needed, indications are that small-scale intensive cultivation can be traced from Greece and the southern Balkans to south-east Hungary.

The most detailed archaeobotanical case for small-scale, intensive crop husbandry concerns the western loess belt and the Alpine Foreland. Bogaard (2004a) carried out ecological analyses comparing modern weed floras from known crop husbandry regimes with archaeobotanical samples of arable weeds associated with charred crop material from Neolithic sites (*c*. 5500–2200 BC) in this broad region. The results suggest that cultivation plots tended to be long established (used for decades or even centuries) rather than temporary plots as in a shifting cultivation regime (see also Bogaard 2002). Furthermore, the major cereal crops (einkorn and emmer) appear to have been sown in the autumn rather than the spring. The implication is that, even where it was topographically feasible, cultivation did not tend to take place within the spring flood zone of rivers and streams. Instead, growing conditions of high soil disturbance and productivity were maintained artificially, with high inputs of labour (e.g. manuring/middening, tillage and weeding).

Cows may have been used as traction animals as early as the LBK (Döhle 1997), a practice that would not alter the scale of cultivation significantly (above, Halstead 1995). The best evidence for the use of oxen as traction animals dates to the Corded Ware phase (*c*. 2800–2400 BC), at the end of the Neolithic sequence in the Alpine Foreland (Hüster-Plogmann and Schibler 1997; Schibler and Jacomet 1999). Though there may have been a trend towards somewhat more extensive cultivation during the later Neolithic, rich charred crop and associated weed assemblages from later Neolithic sites in the loess belt and Alpine Foreland appear to reflect intensively maintained growing conditions and hence a restricted scale of cultivation (Bogaard 2004a).

Discussion

It is clear that farming and herding practices in south-east and central Europe varied regionally and chronologically. Variation in the major crop and livestock species, the importance of dairying, hunting and so on have been linked with regional environmental differences and climate change (e.g. Halstead 1989a; Tresset and Vigne 2001; Schibler 2004). Regional crop husbandry traditions have also been identified (e.g. close similarities in arable weed data among sites in the Lower Rhine-Meuse basin) and site-specific variability can also be explored (e.g. at LBK Vaihingen in the Neckar basin) (Bogaard 2004a: 139–51). Nevertheless, the evidence reviewed above suggests that intensive mixed farming represents the usual pattern across much of south-east and central Europe, despite considerable differences in climate, topography, etc.

The basic similarity of farming systems across these diverse climatic zones raises the question of whether functional integration of crop and livestock husbandry was a uniquely 'European' development or whether it can be traced back to the Near East (Bogaard 2004a: 169–71). Put another way, did the spread of domesticated plants and

animals from the Near East to Europe take place *in the context of* intensive mixed farming?

Crop and animal husbandry in the Near East during the PPNB

The most clearly defined model of Near Eastern crop husbandry in the Neolithic remains Sherratt's (1980) theory of floodplain cultivation, which he also applies to south-east and central Europe; indeed, the model was derived from the survey work of Kruk (1973) in southern Poland. It incorporates three arguments (Sherratt 1980): first, *contra* Childe (1957) and Boserup (1965), there was no 'primeval' swidden phase preceding more intensive forms of agriculture; second, the selective distribution of Neolithic settlement is consistent with a dependence on high groundwater soils for cultivation (lakeside, alluvial, etc.); third, short-season spring growth is possible in cultivated cereals and would be appropriate for soils flooded in winter-early spring, to avoid damage to growing crops. Sherratt (1980) characterizes floodplain plots as 'practically self-cultivating', requiring minimal soil preparation and maintenance. Though he describes the regime as 'horticultural', labour inputs are 'trivial' and include agricultural practices (e.g. broadcast sowing) reminiscent of extensive cultivation.

Sherratt's rejection of shifting cultivation has received wide acceptance, but other aspects of the model have proved problematic in the Near East. Hillman and Davies (1992) argue that spring sowing is unlikely given the requirement of vernalization in wild cereals and the long growth period of einkorn (see also Hillman 1981; Willcox 1999; Fairbairn this volume). Moreover, though some (by no means all) PPNB sites occur near extensive areas of high groundwater, the nature of flooding, silt deposition, etc., will have varied from year to year and from one site to the next. Water availability for crops may have been enhanced in various ways, including small-scale flood irrigation/watering where feasible. The removal of moisture as a limiting factor for crop growth would make it possible to raise productivity further by labour-intensive inputs such as manuring/middening, thorough hand-tillage and weeding.

As in Europe (Charles et al. 2002), small-scale intensive cultivation of cereals in the Near East can hardly be observed today, but its rarity should not be taken as an argument against its relevance to the Neolithic (cf. Halstead 1987). Literature on recent arable farming in the Near East suggests that cereals tend to receive a low level of manure from animals grazing young winter crops or stubble and to be cultivated by ard, plough or tractor, while gardens and orchards tend to receive heavier spreads of farmyard manure and to be worked by hand (Naval Intelligence Division 1944: 447–469; Russel 1957; MacDonald et al. 1959; Poyck 1962; Wirth 1962: 60, 104; Adams 1965: 14). The marked dichotomy between small-scale intensive vegetable cultivation and large-scale cultivation of cereals, however, reflects a variety of factors operating in recent times, including a scarcity of labour and manure and the decline of small-scale land ownership and household subsistence farming (Naval Intelligence Division 1944: 449; Weulersse 1946: 152–3; Wirth 1962: 52, 60–61, 105). In lowland regions, cereals and pulses have occasionally formed a component of recent intensive garden cultivation near settlements (Wirth 1962: 52). In the more isolated valleys of Iraqi Kurdistan, Wirth (1962: 183)

Table 4 Summary of relevant bioarchaeological data for selected PPNB sites in the Fertile Crescent and Cyprus

Regions	*Sites*	*Caprine husbandry*	*Crop husbandry*	*Other evidence*	*Sources*
South-eastern Turkey	Nevalı Çori (NÇ), Çayönü (Ç)	Sheep size decrease due to founder effect (NÇ, Ç); pronounced cull of immature individuals (NÇ)	Potential weed taxa dominated by annuals (Ç)	Spherolites from small ruminant dung in late PPNB deposits (Ç)	van Zeist and de Roller 1991/1992; Brochier 1993; Legge 1996; Peters et al. 1999
Middle Euphrates valley, Syria	Abu Hureyra (AH), Mureybit (M)	Sheep + goat meat-type kill-off (AH) (no evidence for caprine herding at M)	Decrease in wet-loving weeds and increase in 'field' weeds (M); weed flora of dryland cultivation (AH)		Legge 1996; Colledge 2001; Hillman 2000; Legge and Rowley-Conwy 2000
Kermanshah valley, Iran	Ganj Dareh (GD)	Goat meat-type kill-off (GD)		At least part of the archaeobotanical assemblage appears to be dung-derived	van Zeist *et al*. 1984; Legge 1996; Zeder 2001; Charles in press
Damascus basin, Syria	Aswad (A), Ghoraifé (G), Ramad (R)	Goat meat-type kill-off (A), sheep + goat meat-type kill-off (R)	Decrease in wet-loving weeds and increase in 'field' weeds (A, G) (no clear chronological or ecological patterning at R)		Ducos 1993; Legge 1996; Colledge 2001
Cyprus	Mylouthkia (My), Shillourokambos (S)	Sheep + goat meat-type kill-off (S)	Early appearance of crop suite: cereals and flax (My), cereals and pulses (S)	Possible animal pens (S)	Vigne and Buitenhuis 1999; Peltenberg *et al*. 2001; Willcox 2000

describes small-scale cultivation of gardens and fields with intensive manuring, careful weeding and high area yields.

Modern agronomic evidence further demonstrates that manuring benefits cereals and pulses in dry-farming regions of the Near East (Arnon 1972: 353–411; Halstead 1987; Cooper 1991); in lower rainfall areas (< 250 mm per annum), manuring can be detrimental since it encourages early development of the crop, exhausting limited water supplies (Arnon 1972: 381–92). Soil productivity in dry-farming regions is also encouraged by intensive tillage and cereal-legume rotation, as shown by ecological analysis of arable weed survey data from northern Jordan (Bogaard et al. 1999). In sum, the benefits of intensive tillage, manuring and cereal-pulse rotation for crop productivity are well attested in dry-farming regions of the Near East.

Table 4 summarizes relevant bioarchaeological evidence for various regions of the Fertile Crescent during the PPNB, and will be used below to argue the case for intensive mixed farming, as opposed to low-input floodplain cultivation as a parallel but separate activity from extensive pastoralism. The sites included in Table 4 (see also Fig. 1) are those for which information regarding crop and animal husbandry (ideally, livestock mortality data *and* arable weed data on crop growing conditions) is available; this is not intended as an exhaustive survey of PPNB bioarchaeological data (for detailed reviews, see, e.g., Willcox 1998, 1999; Horwitz et al. 1999; Peters et al. 1999; papers in Cappers and Bottema 2002). This discussion is specifically aimed at areas, such as those in Table 4, where reliable dry farming appears to have been feasible in the PPNB; archaeological evidence from the arid margins suggests a distinct sequence of developments (Garrard et al. 1996; Horwitz et al. 1999).

Animal husbandry

Current evidence suggests that herding emerged during the PPNB in the context of established crop cultivation (indicated by morphologically domesticated cereals and/or weed assemblages associated with cereals/pulses (Colledge 1998, 2001; Willcox 1998, 1999, 2002; Zohary and Hopf 2000: 241–2)). PPNB sites with evidence for domesticated livestock have also yielded evidence for cereal/pulse use (Bar-Yosef and Meadow 1995). Thus, herding could potentially have been integrated with cultivation from the outset (cf. Garrard 1984).

The earliest compelling evidence for herding concerns the caprines (sheep and goats); cattle and pig herding appears generally to have emerged somewhat later, and herding of all the major animal domesticates was established by the Final PPNB (Horwitz et al. 1999; Peters et al. 1999). Current evidence points to the probable domestication of sheep as early as the mid–late ninth millennium BC (early PPNB) in south-eastern Turkey (Peters et al. 1999), followed by their introduction as domesticates further south in the middle–late PPNB (Legge 1996; Horwitz et al. 1999); goats may have been domesticated during the early PPNB in south-eastern Turkey (Peters et al. 1999) but claims have also been made for their domestication in the Zagros mountains (Zeder 1999) and the southern Levant (Horwitz et al. 1999). While there was a continued focus on hunting alongside cultivation during the middle PPNB in some regions (e.g. the Mediterranean coastal plain of the southern Levant (Horwitz et al. 1999)), herding of caprines was widespread in the Near

East by the late PPNB (Uerpmann 1996; Legge 1996; Horwitz et al. 1999; Peters et al. 1999).

Caprines are particularly well suited to close integration with cultivation: in addition to grazing crop fields after the harvest, ethnographic evidence suggests that grazing of unripe crops by sheep and goats prevents lodging (a danger in highly fertile plots) and promotes tillering (resulting in short dense crop plants less prone to lodging) (Table 3; Bogaard 2004a: 44; Halstead in press). Sheep are particularly adapted to open terrain and are grazers, unlike goats, which can derive a significant proportion of their diet from browsing of woody perennials (Russell 1988: 58). The fact that sheep increase in importance relative to goat through the PPNB(-C) at some sites (e.g. Çayönü, Abu Hureyra, Ghoraifé, Ain Ghazal) has been interpreted as evidence for reduction in woody vegetation as a result of herding pressure (Legge 1996) or a shift towards nomadic pastoralism (Ducos 1993), but could equally reflect the particular suitability of sheep for grazing arable land and efficiently converting stubble into manure (cf. Harris 2002; Halstead in press;).

Though early domestic goats do not appear to show a marked size decrease (Zeder 2001), early PPNB sheep at Nevalı Çori and later PPNB sheep at Çayönü, both in south-eastern Turkey (Table 4) within the probable zone of wild sheep distribution, show evidence of size reduction due to a 'founder effect' in animals prevented from regular interbreeding with wild sheep (Legge 1996; Peters et al. 1999). This evidence is consistent with small-scale herding and close control of herds in the vicinity of settlements rather than extensive, loosely controlled herds.

Mortality data have been used to distinguish early caprine herd management from hunting (Davis 1987: 159; Ducos 1993; Legge 1996; Vigne and Buitenhuis 1999; Zeder 2001). Culling patterns for early herded caprines consistently reflect a strategy aimed at meat production rather than dairying during the PPNB (Table 4). This is not to say that milking was not practised (Köhler-Rollefson and Rollefson 2002), but rather that herders did not tend to cull lambs/kids in order to remove competition for pasture with lactating females, as in a specialized dairying regime associated with full-time pastoralism (Payne 1973; Legge 1981; Greenfield 1988; Halstead 1998).

In addition to the faunal data, other archaeological evidence also points towards intensive small-scale herding, such as spherolites in soil samples from the late PPNB phases at Çayönü, derived from the dung of small ruminants living near or in the settlement (Brochier 1993), and archaeobotanical evidence for burning of animal dung as fuel (suggesting that livestock were kept within close proximity of the settlement) at a number of early Neolithic sites (Miller 1996; Fairbairn et al. 2002; Charles in press). Ertrug-Yaras (1997) discusses ethnographic evidence for dung use in central Anatolia as *both* fuel and fertilizer, demonstrating that the two uses are not mutually exclusive.

Crop husbandry

Assemblages of arable weeds associated with crop remains in archaeological deposits can potentially reveal the nature of crop husbandry practices. Interpretation of this evidence is complicated, however, by the possible contribution of animal dung burned as fuel to charred crop and 'weed' assemblages (Miller 1996; Charles 1998) – a phenomenon that is itself relevant to understanding of early herding regimes (see

above). This taphonomic complexity makes it more difficult to distinguish the seeds of plants harvested with crops as arable weeds from plants grazed by animals. Nevertheless, statistical analysis of potential arable weed assemblages by Colledge (1998, 2001: 191) has shown that there are decreases in wet-loving species and increases in the occurrence of 'field weeds' (able to recover rapidly from repeated soil disturbance) during the PPNB at sites in the Middle Euphrates region and the Damascus Basin (Table 4), suggesting decreasing reliance on areas of high groundwater and increasingly intensive disturbance (e.g. tillage and weeding). Even if these potential arable weed assemblages derive from animal dung fuel, the trend towards less wet but more disturbed grazing habitats would also be consistent with a developing link between arable and pastoral activities – in other words, the increasing use of intensively managed arable land as pasture for intensively managed livestock. Also relevant is the archaeobotanical assemblage from later PPNB Çayönü, which is relatively rich in seeds from a range of wild taxa that may have been harvested as arable weeds (van Zeist and de Roller 1991–2). Among the potential weed taxa of known life history (that is, identified to species or to a genus that is uniformly annual or perennial), all are annuals, inherently adapted to frequent soil disturbance due to their short life-cycle (Table 4; cf. Bogaard 2002).

The emergence of a broad set of crops (cereals, pulses, flax) across the Fertile Crescent in the course of the PPNB provides further support for intensive crop husbandry. The spread of an established suite of cereals contrasts with the situation in the PPNA period, when locally available wild cereals, adapted to naturally available growing conditions at each site, appear to have predominated (Willcox 1999, 2002). As growing conditions became increasingly artificial and highly managed, the cultivation of a standard range of crops became feasible. Rotation of cereals and pulses can play a key role in the maintenance of long-term soil fertility in small-scale intensive farming (Halstead 1987; Palmer 1998a, 1998b).

Discussion

A tendency towards small-scale herding and intensive cultivation can be detected at PPNB sites across the Fertile Crescent (Table 4), but integrated regimes did not emerge simultaneously across the whole region; rather, intensive farming elements came together at varying rates, crystallizing earlier in some areas (south-east Turkey?) than others. This complexity underlines the need for more bioarchaeological investigations (especially into potential arable weed floras, cf. Colledge 1998, 2001) as well as consideration of how changing farming practices related to household and community structure, including the 'overgrown villages' (*c.* 10 + ha) of the later PPNB.

The appearance on Cyprus of imported caprines, pigs and cattle by the end of the ninth millennium BC (early–middle PPNB), together with einkorn, emmer, barley, flax and pulses, is worth mentioning in association with the emergence of intensive mixed farming (Table 4; Vigne and Buitenhuis 1999; Peltenberg et al. 2001). The early date of the Cypriot evidence supports the case for integration of crop and livestock husbandry by the later part of the early PPNB on the mainland, most likely in south-east Turkey (Peters et al. 1999; Vigne and Buitenhuis 1999; Willcox 2003).

Conclusions

Though the balance of arable and pastoral activities and intensity of management will have varied from household to household, site to site and from one year to the next, bioarchaeological evidence for early farming in the Near East and Europe supports the intensive mixed farming model. This regime 'financed' the relatively autonomous household as the fundamental constituent of early farming communities. Increasing household autonomy can be traced through changes in domestic architecture and food preparation/consumption in the PPNB (Flannery 1972, 2002; Byrd 2000; Wright 2000), and the established household is evident in the villages, hamlets and lone farmsteads of Neolithic Europe. By synthesizing evidence for early crop and animal husbandry in these broad regions, it is hoped that attention may usefully be focused on *how* early farming was practised and, more importantly, the role of these routine practices in shaping Neolithic communities.

Acknowledgements

I am indebted to Mike Charles, Paul Halstead, Katheryn Twiss and anonymous referees for constructive criticism and useful bibliographic references. I would also like to thank Marijke van der Veen, for her editorial advice and patience, and David Taylor, for drawing Figure 1.

Department of Archaeology,
University of Nottingham, UK

References

Adams, R. M. 1965. *Land behind Baghdad: A History of Settlement on the Diyala Plains*. Chicago, IL: University of Chicago Press.

Akeret, Ö. and Jacomet, S. 1997. Analysis of plant macrofossils in goat/sheep faeces from the Neolithic lake shore settlement of Horgen Scheller – an indication of prehistoric transhumance? *Vegetation History and Archaeobotany* 6: 235–9.

Akeret, Ö., Haas, J. N., Leuzinger, U. and Jacomet, S. 1999. Plant macrofossils and pollen in goat/sheep faeces from the Neolithic lake-shore settlement Arbon Bleiche 3, Switzerland. *The Holocene*, 9: 175–82.

Arbogast, R.-M. 1994. *Premiers élevages néolithiques du nord-est de la France*. Liège: Etudes et Recherches Archéologiques de l'Université de Liège.

Arnon, I. 1972. *Crop Production in Dry Regions*, Vol. 1, *Background and Principles*. London: Leonard Hill.

Bakels, C. C. 1997. The beginnings of manuring in western Europe. *Antiquity*, 71: 442–5.

Barker, G. 1985. *Prehistoric Farming in Europe*. Cambridge: Cambridge University Press.

Bartosiewicz, L. in press. Animal bone. In *The Early Neolithic on the Great Hungarian Plain: Investigations of the Körös Culture Site of Ecsegfalva 23, Co. Békés* (ed. A. Whittle). Budapest: Hungarian Academy of Sciences.

Bar-Yosef, O. and Meadow, R. H. 1995. The origins of agriculture in the Near East. In *Last Hunters – First Farmers: New Perspectives on the Prehistoric Transition to Agriculture* (eds T. D. Price and A. B. Gebauer). Santa Fe, NM: School of American Research Press, pp. 39–94.

Bender, B. 1978. Gatherer-hunter to farmer: a social perspective. *World Archaeology*, 10: 204–22.

Benecke, N. 1994. *Archäozoologische Studien zur Entwicklung der Haustierhaltung in Mitteleuropa und Südskandinavien von den Anfängen bis zum ausgehenden Mittelalter*. Berlin: Akademie Verlag.

Bogaard, A. 2002. Questioning the relevance of shifting cultivation to Neolithic farming in the loess belt of western-central Europe: evidence from the Hambach Forest experiment. *Vegetation History and Archaeobotany*, 11: 155–68.

Bogaard, A. 2004a. *Neolithic Farming in Central Europe*. London: Routledge.

Bogaard, A. 2004b. The nature of early farming in central and south-east Europe. *Documenta Praehistorica*, 31, pp. 49–58.

Bogaard, A., Palmer, C., Jones, G., Charles, M. and Hodgson, J. G. 1999. A FIBS approach to the use of weed ecology in the archaeobotanical recognition of crop rotation. *Journal of Archaeological Science*, 26: 1211–24.

Bogaard, A., Bending, J. and Jones, G. in press a. Archaeobotanical evidence for plant husbandry and use at Ecsegfalva 23. In *The Early Neolithic on the Great Hungarian Plain: Investigations of the Körös Culture Site of Ecsegfalva 23, Co. Békés* (ed. A. Whittle). Budapest: Hungarian Academy of Sciences.

Bogaard, A., Bending, J. and Jones, G. in press b. Crop husbandry and its social significance in the Körös and LBK periods. In *New Perspectives on Neolithic Sedentism* (eds D. Bailey, A. Whittle and V. Cummings).

Bogucki, P. 1988. *Forest Farmers and Stockherders*. Cambridge: Cambridge University Press.

Bogucki, P. 1999. *The Origins of Human Society*. Oxford: Blackwell.

Bökönyi, S. 1992. The Early Neolithic vertebrate fauna of Endröd 119. In *Cultural and Landscape Changes in South-East Hungary I: Reports on the Gyomaendröd Project* (ed. S. Bökönyi). Budapest: Archaeolingua, pp. 195–300.

Boserup, E. 1965. *The Conditions of Agricultural Growth*. New York: Aldine.

Brochier, J. E. 1993. Çayönü tepesi: domestication, rythmes et environnement au PPNB. *Paléorient*, 19: 39–49.

Byrd, B. F. 2000. Households in transition: Neolithic social organisation within southwest Asia. In *Life in Neolithic Farming Communities: Social Organisation, Identity and Differentiation* (ed. I. Kuijt). New York: Academic/Plenum, pp. 63–98.

Cappers, R. T. J. and Bottema, S. (eds) 2002. *The Dawn of Farming in the Near East*. Berlin: ex oriente.

Charles, M. 1998. Fodder from dung: the recognition and interpretation of dung-derived plant material from archaeological sites. *Environmental Archaeology*, 1: 111–22.

Charles, M. in press. East of Eden? A consideration of Neolithic crop spectra in the eastern Fertile Crescent and beyond. In *Archaeobotanical Perspectives on the Origin and Spread of Agriculture in Southwest Asia and Europe* (eds S. Colledge and J. Conolly). London: UCL Press.

Charles, M., Bogaard, A., Jones, G., Hodgson, J. G. and Halstead, P. 2002. Towards the archaeobotanical identification of intensive cereal cultivation: present-day ecological investigation in the mountains of Asturias, northwest Spain. *Vegetation History and Archaeobotany*, 11: 133–42.

Cauvin, J. 2000. *The Birth of the Gods and the Origins of Agriculture*. Cambridge: Cambridge University Press.

Childe, V. G. 1957. *The Dawn of European Civilization*. London: Routledge.

Colledge, S. 1998. Identifying pre-domestication cultivation using multivariate analysis. In *The Origins of Agriculture and Crop Domestication* (eds A. B. Damania, J. Valkoun, G. Willcox and C. O. Qualset). Aleppo: International Center for Agricultural Research in Dry Areas, pp. 121–31.

Colledge, S. 2001. *Plant Exploitation on Epipaleolithic and Early Neolithic Sites in the Levant*. Oxford: British Archaeological Reports, International Series.

Cooper, P. J. M. 1991. Fertiliser use, crop growth, water use and water use efficiency in Mediterranean rainfed farming systems. In *Soil and Crop Management for Improved Water Use Efficiency in Rainfed Areas* (eds H. C. Harris, P. J. M. Cooper and M. Pala), Aleppo: International Center for Agricultural Research in Dry Areas, pp. 135–52.

Craig, O. E., Heron, C., Willis, L. H., Yusof, N. N. H. A. and Taylor, G. in press. Organic residue analysis of pottery vessels. In *The Early Neolithic on the Great Hungarian Plain: Investigations of the Körös Culture Site of Ecsegfalva 23, Co. Békés* (ed. A. Whittle). Budapest: Hungarian Academy of Sciences.

Davis, S. J. M. 1987. *The Archaeology of Animals*. London: Batsford.

Döhle, H.-J. 1997. Zum Stand der Untersuchungen an neolithischen Tierknochen aus Mitteldeutschland. *Jahresschrift für mitteldeutsche Vorgeschichte*, 79: 111–47.

Ducos, P. 1993. Proto-élevage et élevage au Levant sud au VIIe millénaire B.C. Les données de la Damascène. *Paléorient*, 19: 153–73.

Ducos, P. 1994. À propos du modèle du pastoralisme PPNC proposé par G. Rollefson et I. Köhler-Rollefson. *Paléorient*, 20: 165–6.

Ertrug-Yaras, F. 1997. An ethnoarchaeological study of subsistence and plant gathering in Central Anatolia. PhD dissertation, Washington University, St. Louis.

Fairbairn, A. 2005. A history of agricultural production at Neolithic Çatalhöyük East, Turkey. *World Archaeology*, 37(2): 197–210.

Fairbairn, A. S., Asouti, E., Near, J. and Martinoli, D. 2002. Macro-botanical evidence for plant use at Neolithic Çatalhöyük. *Vegetation History and Archaeobotany*, 11: 41–54.

Flannery, K. V. 1969. Origins and ecological effects of early domestication in Iran and the Near East. In *The Domestication and Exploitation of Plants and Animals* (eds P. J. Ucko and G. W. Dimbleby). London: Duckworth, pp. 73–100.

Flannery, K. V. 1972. The origins of the village as a settlement type in Mesoamerica and the Near East: a comparative study. In *Man, Settlement and Urbanism* (eds P. J. Ucko, R. Tringham and G. W. Dimbleby). London: Duckworth, pp. 23–53.

Flannery, K. V. 2002. The origins of the village revisited: from nuclear to extended households. *American Antiquity*, 67: 417–33.

Forbes, H. 1982. Strategies and soils: technology, production and environment in the peninsula of Methana, Greece. PhD dissertation, University of Pennsylvania. Ann Arbor: University Microfilms International.

Garrard, A. 1984. The selection of south-west Asian animal domesticates. In *Animals in Archaeology 3: Early Herders and their Flocks* (eds J. Clutton-Brock and C. Grigson). Oxford: British Archaeological Reports, International Series 202, pp. 117–32.

Garrard, A., Colledge, S. and Martin L. 1996. The emergence of crop cultivation and caprine herding in the 'Marginal Zone' of the southern Levant. In *The Origins and Spread of Agriculture and Pastoralism in Eurasia* (ed. D. R. Harris). London: UCL Press, pp. 204–26.

Goring-Morris, A.N. and Belfer-Cohen, A. 2003. Structures and dwellings in the Upper and Epi-Palaeolithic (ca. 42–10 K BP) Levant: profane and symbolic uses. In *Perceived Landscapes and Built Environments* (eds O. Soffer, S. Vasil'ev and J. Kozlowski). Oxford: British Archaeological Reports, International Series 1122, pp. 65–81.

Greenfield, H. 1988. The origins of milk and wool production in the Old World. *Current Anthropology*, 29: 573–93.

Gross, E., Jacomet, S. and Schibler, J. 1990. Stand und Ziele der Wirtschaftsarchäologischen Forschung an neolithischen Ufer- und Inselsiedlungen im unteren Zürichseeraum (Kt. Zürich, Schweiz). In *Beiträge zur Archäozoologie, Archäologie, Anthropologie, Geologie und Paläotologie (Festschrift H. R. Stampfli)* (eds J. Schibler, J. Sedlmeier and H. Spycher). Basel: Helbig & Lichtenhahn, pp. 77–100.

Halstead, P. 1981. Counting sheep in Neolithic and Bronze Age Greece. In *Pattern of the Past: Studies in Honour of David Clarke* (eds I. Hodder, G. Isaac and N. Hammond). Cambridge: Cambridge University Press, pp. 307–39.

Halstead, P. 1987. Traditional and ancient rural economy in Mediterranean Europe: plus ça change? *Journal of Hellenic Studies*, 107: 77–87.

Halstead, P. 1989a. Like rising damp? An ecological approach to the spread of farming in south east and central Europe. In *The Beginnings of Agriculture* (eds A. Milles, D. Williams and N. Gardner). Oxford: British Archaeological Reports, International Series 496, pp. 23–53.

Halstead, P. 1989b. The economy has a normal surplus: economic stability and social change among early farming communities of Thessaly, Greece. In *Bad Year Economics: Cultural Responses to Risk and Uncertainty* (eds P. Halstead and J. O'Shea). Cambridge: Cambridge University Press, pp. 68–80.

Halstead, P. 1995. Plough and power: the economic and social significance of cultivation with the ox-drawn ard in the Mediterranean. *Bulletin on Sumerian Agriculture*, 8: 11–22.

Halstead, P. 1996a. Pastoralism or household-herding? Problems of scale and specialization in early Greek animal husbandry. *World Archaeology*, 28: 20–42.

Halstead, P. 1996b. The development of agriculture and pastoralism in Greece: when, how, who and what? In *The Origins and Spread of Agriculture and Pastoralism in Eurasia* (ed. D. R. Harris). London: UCL Press, pp. 296–309.

Halstead, P. 1998. Mortality models and milking: problems of uniformitarianism, optimality and equifinality reconsidered. *Anthropozoologica*, 27: 3–20.

Halstead, P. 2000. Land use in postglacial Greece: cultural causes and environmental effects. In *Landscape and Land Use in Postglacial Greece* (eds P. Halstead and C. Frederick). Sheffield: Sheffield Academic Press, pp. 110–28.

Halstead, P. in press. Sheep in the garden: the integration of crop and livestock husbandry in early farming regimes of Greece and southern Europe. In D. Field and D. Serjeantson (eds) *Animals in the Neolithic*. Oxford: Oxbow.

Harris, D. R. 2002. Development of the agro-pastoral economy in the Fertile Crescent during the Pre-Pottery Neolithic period. In *The Dawn of Farming in the Near East* (eds R. T .J. Cappers and S. Bottema). Berlin: ex oriente, pp. 67–83.

Hayden, B. 1990. Nimrods, piscators, pluckers and planters: the emergence of food production. *Journal of Anthropological Archaeology*, 9: 31–69.

Hayden, B. 1995. Pathways to power: principles for creating socioeconomic inequalities. In *Foundations of Social Inequality* (eds T. D. Price and G. M. Feinman). New York: Plenum, pp. 15–86.

Hillman, G. C. 1981. Reconstructing crop husbandry practices from charred remains of crops. In *Farming Practice in British Prehistory* (ed. R. Mercer). Edinburgh: Edinburgh University Press, pp. 123–62.

Hillman, G. C. 2000. Overview: the plant-based components of subsistence in Abu Hureyra 1 and 2. In *Village on the Euphrates: from Foraging to Farming at Abu Hureyra* (eds A. M. T. Moore, G. C. Hillman and A. J. Legge), Oxford: Oxford University Press, pp. 416–22.

Hillman, G. C. and Davies, M. S. 1992. Domestication rates in wild wheats and barley under primitive cultivation: preliminary results and archaeological implications of field measurements of selection coefficient. In *Préhistoire de l'agriculture: nouvelles approaches expérimentales et ethnographiques* (ed. P. C. Anderson). Paris: Editions du Centre National de la Recherche Scientifique, pp. 113–58.

Horwitz, L. K., Tchernov, E., Ducos, P., Becker, C., von den Driesch, A., Martin, L. and Garrard, A. 1999. Animal domestication in the southern Levant. *Paléorient*, 25: 63–80.

Hüster-Plogmann, H. and Schibler, J. 1997. Archäozoologie. In *Ökonomie und Ökologie neolithischer und bronzezeitlicher Ufersiedlungen am Zürichsee* (eds J. Schibler, H. Hüster-Plogmann, S. Jacomet, C. Brombacher, E. Gross-Klee and A. Rast-Eicher). Zurich: Zürich & Egg, pp. 40–121.

Jarman, M. R., Bailey, G. N. and Jarman, H. N. 1982. *Early European Agriculture*. Cambridge: Cambridge University Press.

Jones, G. 2005. Garden cultivation of staple crops and its implications for settlement location and continuity. *World Archaeology* 37(2): 164–76.

Köhler-Rollefson, I. 1992. A model for the development of nomadic pastoralism on the Transjordan Plateau. In *Pastoralism in the Levant* (eds O. Bar-Yosef and A. Khazanov). Madison, WI: Prehistory Press, pp. 11–18.

Köhler-Rollefson, I. and Rollefson, G. O. 2002. Brooding about breeding: social implications for the process of animal domestication. In *The Dawn of Farming in the Near East* (eds R. T. J. Cappers and S. Bottema). Berlin: ex oriente, pp. 177–81.

Kruk, J. 1973. *Studia Osadnicze nad Neolitem Wyzyn Lessowych*. Warsaw: Polska Akademia Nauk, Instytut Historii Kultury Materialnej.

Legge, A. J. 1981. The agricultural economy. In *Grimes Graves Excavations 1971–1972* (ed. R. Mercer). London: Her Majesty's Stationery Office, pp. 79–103.

Legge, A. J. 1996. The beginning of caprine domestication in southwest Asia. In *The Origins and Spread of Agriculture and Pastoralism in Eurasia* (ed. D. R. Harris). London: UCL Press, pp. 238–62.

Legge, A. J. and Rowley-Conwy, P. 2000. The exploitation of animals. In *Village on the Euphrates: from Foraging to Farming at Abu Hureyra* (eds A. M. T. Moore, G. C. Hillman and A. J. Legge), Oxford: Oxford University Press, pp. 423–71.

Lüning, J. 2000. *Steinzeitliche Bauern in Deutschland – die Landwirtschaft im Neolithikum*. Bonn: Dr. Rudolf Habelt GmbH.

MacDonald, Sir M. and Partners 1959. *Diyala and Middle Tigris Projects. Report no. 4. Middle Diyala Development: Soils, Agriculture, Irrigation and Drainage*. London: Government of Iraq, Development Board, 1st Technical Section.

Mainland, I. in press. A microwear analysis of selected sheep and goat mandibles from Ecsegfalva. In *The Early Neolithic on the Great Hungarian Plain: Investigations of the Körös Culture Site of Ecsegfalva 23, Co. Békés* (ed. A. Whittle). Budapest: Hungarian Academy of Sciences.

Marinova, E. M. 2001. Vergleichende paläoethnobotanische Untersuchung zur Vegetationsgeschichte und zur Entwicklung der prähistorischen Landnutzung in Bulgarien. Unpublished PhD dissertation, Rheinisch Friedrich-Wilhelms-Universität Bonn.

Miller, N. F. 1996. Seed eaters of the ancient Near East: human or herbivore? *Current Anthropology*, 37: 521–8.

Naval Intelligence Division 1944. *Iraq and the Persian Gulf*. London: Geographical Handbook Series.

Netting, R. M. 1971. *The Ecological Approach to Cultural Study*. Reading, MA: Addison-Wesley Modular.

Netting, R. M. 1990. Population, permanent agriculture and polities: unpacking the evolutionary portmanteau. In *The Evolution of Political Systems* (ed. S. Upham). Cambridge: Cambridge University Press, pp. 21–61.

Overgaard Nielsen, B., Mahler, V. and Rasmussen, P. 2000. An arthropod assemblage and the ecological conditions in a byre at the Neolithic settlement of Weier, Switzerland. *Journal of Archaeological Science*, 27: 209–18.

Palmer, C. 1998a. An exploration of the effects of crop rotation regime on modern weed floras. *Environmental Archaeology*, 2: 35–48.

Palmer, C. 1998b. The role of legumes in the farming system: a case study from northern Jordan. *Environmental Archaeology*, 1: 1–10.

Payne, S. 1973. Kill-off patterns in sheep and goats: the mandibles from Asvan Kalé. *Anatolian Studies*, 23: 281–303.

Peltenberg, E., Colledge, S., Croft, P., Jackson, A., McCartney, C. and Murray, M. A. 2001. Neolithic dispersals from the Levantine Corridor: a Mediterranean perspective. *Levant*, 33: 35–64.

Peters, J., Helmer, D., Driesch, von den A. and Sana Segui, M. 1999. Early animal husbandry in the northern Levant. *Paléorient*, 25: 27–47.

Pike-Tay, A. in press. Skeletochronological evidence for seasonal culling of ovicaprids. In *The Early Neolithic on the Great Hungarian Plain: Investigations of the Körös Culture Site of Ecsegfalva 23, Co. Békés* (ed. A. Whittle). Budapest: Hungarian Academy of Sciences.

Poyck, A. P. G. 1962. *Farm Studies in Iraq: An Agro-economic Study of the Agriculture in the Hilla-Diwaniya Area in Iraq*, Vol. 62, No. 1. Mededelingen van de Landboouwhogeschool te Wageningen.

Rasmussen, P. 1993. Analysis of sheep/goat faeces from Egolzwil 3, Switzerland: evidence for branch and twig foddering of livestock in the Neolithic. *Journal of Archaeological Science*, 20: 479–502.

Robinson, D. and Rasmussen, P. 1989. Botanical investigations at the Neolithic lake village at Weier, north east Switzerland: leaf hay and cereals as animal fodder. In *The Beginnings of Agriculture* (eds A. Milles, D. Williams and N. Gardner). Oxford: British Archaeological Reports, International Series 496, pp. 149–63.

Rowley-Conwy, P. 1981. Slash and burn in the temperate European Neolithic. In *Farming Practice in British Prehistory* (ed. R. Mercer). Edinburgh: Edinburgh University Press, pp. 85–96.

Runnels, C. and Van Andel, T. 1988. Trade and the origins of agriculture in the eastern Mediterranean. *Journal of Mediterranean Archaeology*, 1: 83–109.

Russel, J. C. 1957. *Tillage Practices in Iraq*. Baghdad: College of Agriculture, Abu Ghraib.

Russell, K. W. 1988. *After Eden: The Behavioural Ecology of Early Food Production in the Near East and North Africa*. Oxford: British Archaeological Reports, International Series 391.

Schibler, J. 2004. Bones as a key for reconstructing the environment, nutrition and economy of the lake-dwelling societies. In *Living on the Lake in Prehistoric Europe* (ed. F. Menotti). London: Routledge, pp. 144–61.

Schibler, J. and Jacomet, S. 1999. Archaeozoological and archaeobotanical evidence of human impact on Neolithic environments in Switzerland. In *The Holocene History of the European Vertebrate Fauna* (ed. N. Benecke). Rahden: Verlag Marie Leidorf, pp. 339–54.

Sherratt, A. 1980. Water, soil and seasonality in early cereal cultivation. *World Archaeology*, 2: 313–30.

Sherratt, A. 1999. Cash-crops before cash: organic consumables and trade. In *Prehistory of Food: Appetites for Change* (eds C. Gosden and J. Hather). London: Routledge, pp. 13–34.

Thomas, J. 1999. *Understanding the Neolithic*. London: Routledge.

Tresset, A. and Vigne, J.-D. 2001. La chasse, principal élément structurant la diversité des faunes archéologiques du Néolithique ancien, en Europe tempérée et en Méditerranée: tentative d'interpretation fonctionelle. In *Premières rencontres danubiennes, Strasbourg 20 et 21 novembre 1996, Actes de la première table-ronde: Rôle et statut de la chasse dans le Néolithique ancien danubien (5500–4900 av. J.-C.)* (eds R.-M. Arbogast, C. Jeunesse and J. Schibler). Rahden: Verlag Marie Leidorf, pp. 129–51.

Uerpmann, H.-P. 1996. Animal domestication – accident or intention? In *The Origins and Spread of Agriculture and Pastoralism in Eurasia* (ed. D. R. Harris). London: UCL press, pp. 227–37.

Valamoti, S. 2004. *Plants and People in Late Neolithic and Early Bronze Age Northern Greece: An Archaeobotanical Investigation*. Oxford: British Archaeological Reports, International Series 1258.

Valamoti, S. and Jones, G. 2003. Plant diversity and storage at Mandalo, Macedonia, Greece: archaeobotanical evidence from the Final Neolithic and Early Bronze Age. *Annual of the British School at Athens*, 98: 1–35.

Vigne, J.-D. and Buitenhuis, H. 1999. Les premiers pas de la domestication animale à l'ouest de l'Euphrate: Chypre et l'Anatolie centrale. *Paléorient*, 25: 27–47.

Wasse, A. 1997. Preliminary results of an analysis of sheep and goat bones from 'Ain Ghazal, Jordan. In *The Prehistory of Jordan II: Perspectives from 1997* (eds H. G. K. Gebel, Z. Kafafi and G. O. Rollefson). Berlin: ex oriente, pp. 575–92.

Weulersse, J. 1946. *Paysans de Syrie et du Proche-Orient*. Paris: Gallimard.

Whittle, A. 1996. *Europe in the Neolithic*. Cambridge: Cambridge University Press.

Willcox, G. 1998. Archaeobotanical evidence for the beginnings of agriculture in southwest Asia. In *The Origins of Agriculture and Crop Domestication* (eds A. B. Damania, J. Valkoun, G. Willcox and C. O. Qualset). Aleppo: International Center for Agricultural Research in Dry Areas, pp. 25–38.

Willcox, G. 1999. Agrarian change and the beginnings of cultivation in the Near East: evidence from wild progenitors, experimental cultivation and archaeobotanical data. In *The Prehistory of Food: Appetites for Change* (eds C. Gosden and J. G. Hather). London: Routledge, pp. 478–500.

Willcox, G. 2000. Présence des céréales dans le Néolithique pré-céramique de Shillourokambos à Chypre. *Paléorient*, 26: 129–35

Willcox, G. 2002. Geographical variation in major cereal components and evidence for independent domestication in Western Asia. In *The Dawn of Farming in the Near East* (eds R. T. J. Cappers and S. Bottema). Berlin: ex oriente, pp. 133–40.

Willcox, G. 2003. The origins of Cypriot farming. In *Le Néolithique de Chypre* (eds J. Guilaine and A. Le Brun). Athens: École Française d'Athène, pp. 231–8.

Wirth, E. 1962. *Agrargeographie des Irak*. Hamburg: Cram de Gruyter.

Wright, K. 2000. The social origins of cooking and dining in early villages of western Asia. *Proceedings of the Prehistoric Society*, 66: 89–121.

Zeder, M. A. 1999. Animal domestication in the Zagros: a review of past and current research. *Paléorient*, 25: 11–25.

Zeder, M. A. 2001. A metrical analysis of a collection of modern goats (*Capra hircus aegargus* and *C.h. hircus*) from Iran and Iraq: implications for the study of caprine domestication. *Journal of Archaeological Science*, 28: 61–79.

van Zeist, W. and de Roller, G. J. 1991–2. The plant husbandry of Aceramic Çayönü, SE Turkey. *Palaeohistoria*, 33–4: 65–96.

van Zeist, W., Smith, P. E. L., Palfenier-Vegter, R. M., Suwijn, M. and Casparie, W. 1984. An archaeobotanical study of Ganj Dareh Tepe, Iran. *Palaeohistoria*, 26: 201–24.

Zohary, D. and Hopf, M. 2000. *Domestication of Plants in the Old World*. Oxford: Oxford University Press.

Biographical Notes

Amy Bogaard completed her PhD at the Department of Archaeology, University of Sheffield in 2002 and is now a lecturer in the Department of Archaeology, University of Nottingham. She is involved in archaeobotanical work on Neolithic sites in Germany, Hungary, Romania, Greece and Turkey.