MAN AND OTHER ANIMALS IN LATER GREEK PREHISTORY[1]

HALF a century has elapsed since the first major synthesis of animal husbandry in Greek prehistory. In 1936, drawing on the observations of early excavators and on occasional specialist reports by zoologists, Vickery concluded that 'The peoples of the prehistoric Aegean, even in neolithic times, kept sheep, goats, swine and cattle'. Sheep and goats usually predominated, followed by pigs and then cattle, so that pigs were far commoner in prehistoric than in traditional Greek husbandry. There was artistic evidence that livestock provided milk as well as meat and that hunting, sparsely represented in bone finds, was important as an aristocratic sport. Fishing, by contrast, though taking a low profile in the heroic world of Homer, seemed well attested by artefactual evidence and so may have made a significant contribution to the diet of lesser mortals. To their credit, some early workers considered whether bones had been thrown into deposits as rubbish, placed as offerings, or merely washed in by the elements. At a more detailed level, spit roasting had been identified from partially burnt bones. Finally, Vickery discussed the possibility that some upland sites were the remains of seasonal herding camps—a rather fashionable notion today.[2]

Now, fifty years later, there has been a vast increase in both the quantity and quality of archaeozoological data, but to improve on Vickery's synthesis is not an easy task, for two principal reasons. Firstly, the growing wave of archaeozoological studies of the last thirty years has, with a few notable exceptions, largely failed to address questions of importance to prehistorians. In common with studies of the material culture from excavations, bone reports have, at their best, concentrated on presenting certain traditional categories of quantitative and metrical data, rather than on posing explicit questions and trying to develop methods to answer them. For this failure to address relevant questions, excavators and archaeozoologists alike are to blame.

Ironically, the second major obstacle to a new synthesis is the growing and laudable awareness, throughout archaeology, that we need to pay far more attention to the processes by which the archaeological record is formed—i.e. the entire sequence of distorting filters which lie between the prehistoric human beings whose behaviour we seek to study and the summary 'data' which appear in archaeological publications.[3] Fortunately, archaeozoologists have been in the forefront of this concern with formation processes and Payne in his 'Reader's Guide' to archaeozoology in Greece has discussed the problems posed by these filters with specific reference to the Aegean.[4]

As Payne points out, at one end of this sequence we have filters of our own making—the bones which survive in the ground are subjected to partial recovery by excavators and idiosyncratic

[1] A version of this paper was delivered at the December 1985 meeting of the Archaeological Institute of America in Washington, at the invitation of Dr Julie Hansen. Attendance at the meeting was made possible by grants from the Foreign Travel Fund of Sheffield University and the AIA. For helpful comments on earlier drafts, I am indebted to John Henderson, Richard Hubbard, Glynis Jones, Harold Koster, Tony Legge, John O'Shea, and Peter Rowley-Conwy.

[2] K. F. Vickery, *Food in Early Greece* (Illinois Studies in the Social Sciences 20, 3) (University of Illinois 1936).

[3] D. L. Clarke, 'Archaeology: the Loss of Innocence', *Antiquity* 47 (1973) 6–18.

[4] S. Payne, 'Zoo-archaeology in Greece: a Reader's Guide', in N. C. Wilkie and W. D. E. Coulson (eds.) *Contributions to Aegean Archaeology: Studies in Honor of William A. McDonald* (University of Minnesota, Center for Ancient Studies 1985) 211–44. Also contains a full bibliography of archaeozoological work in Greece.

analysis by archaeozoologists, so severely prejudicing interpretation and effectively precluding detailed comparison between sites. It may not even be valid to compare assemblages of different date from the same site, as fascination with the 'Origins of Agriculture' question may evidently lead to more careful recovery in Early Neolithic than in later levels.[5] Although commonly agreed solutions to problems of recovery and analysis are not within sight, these filters are potentially within our control and even explicit statement of methods used in each case would resolve some of the current confusion.

The bones available for recovery and analysis have of course already been subjected to selective loss: through decay in the ground; through gnawing by dogs or weathering before burial; through human choices of which animals to use for what, of how to process their carcasses and, perhaps less consciously, of where to discard their bones. These selective filters are not directly within our control but, through observation of processes such as bone destruction in the present and through detailed contextual study of faunal assemblages, we can at least recognize which selective processes have been at work. Moreover, the study of pre-depositional filters can produce information which is interesting in its own right—a point which may be reinforced with two examples.

The excavation by Koukouli-Khrisanthaki of an Early Iron Age cemetery at Theologos on Thasos (FIG. 1) raised the question of whether animal bones found in the tombs were from grave offerings. Most of these bones were small fragments, which could well have entered the tombs as chance components of their earth fill. The remaining large bones, however, were all complete femurs, that is bones well endowed with meat but very vulnerable to attrition, of young cow and horse and came from the left side of the body. These bones were clearly deliberate human introductions.[6]

The second example concerns the Late Neolithic cave of Kalythies on Rhodes, where conversely human bones were freely intermingled with those of other animals, apparently in occupation levels. Again the representation of body parts proved interesting, though for now only the human remains will be discussed. These were almost exclusively small hand and foot bones and loose teeth, mostly front teeth rather than cheek teeth—that is precisely the elements normally missing from excavated human skeletons. Graves were not recognized, therefore, because the material had been left behind after the removal for secondary burial of bodies temporarily buried or exposed in the cave. Incidentally, the extreme clarity of this pattern is largely due to intensive sieving by Sampson, the excavator.[7]

These studies of formation processes have produced information of considerable intrinsic interest, but it is the investigation of animal husbandry which is widely perceived as the major objective of archaeozoology. In addressing this problem, three questions will be posed, of increasing difficulty and increasing importance:

(1) which species were exploited where and when?
(2) how was each species managed?
(3) what was the role of animal husbandry in the overall economy?

The first question was largely answered by Vickery. Which, if any, of the common livestock species was locally domesticated in Greece is an issue outside the scope of this paper, but sheep, goat, cow, and pig were all present from the beginning of settled village life in the Early Neolithic

[5] Ibid. 222 table 2.

[6] P. Halstead and G. Jones, 'Animal Bones and Burial Customs in Early Iron Age Thasos: the Faunal Remains from the Cemeteries at Theologos' (*in press*).

[7] Id., 'Bioarchaeological Remains from Kalythies Cave, Rhodes', in A. Sampson, '*Η Νεολιθικη Περιοδος στα Δωδεκανησα*', *ADelt* (*in press*).

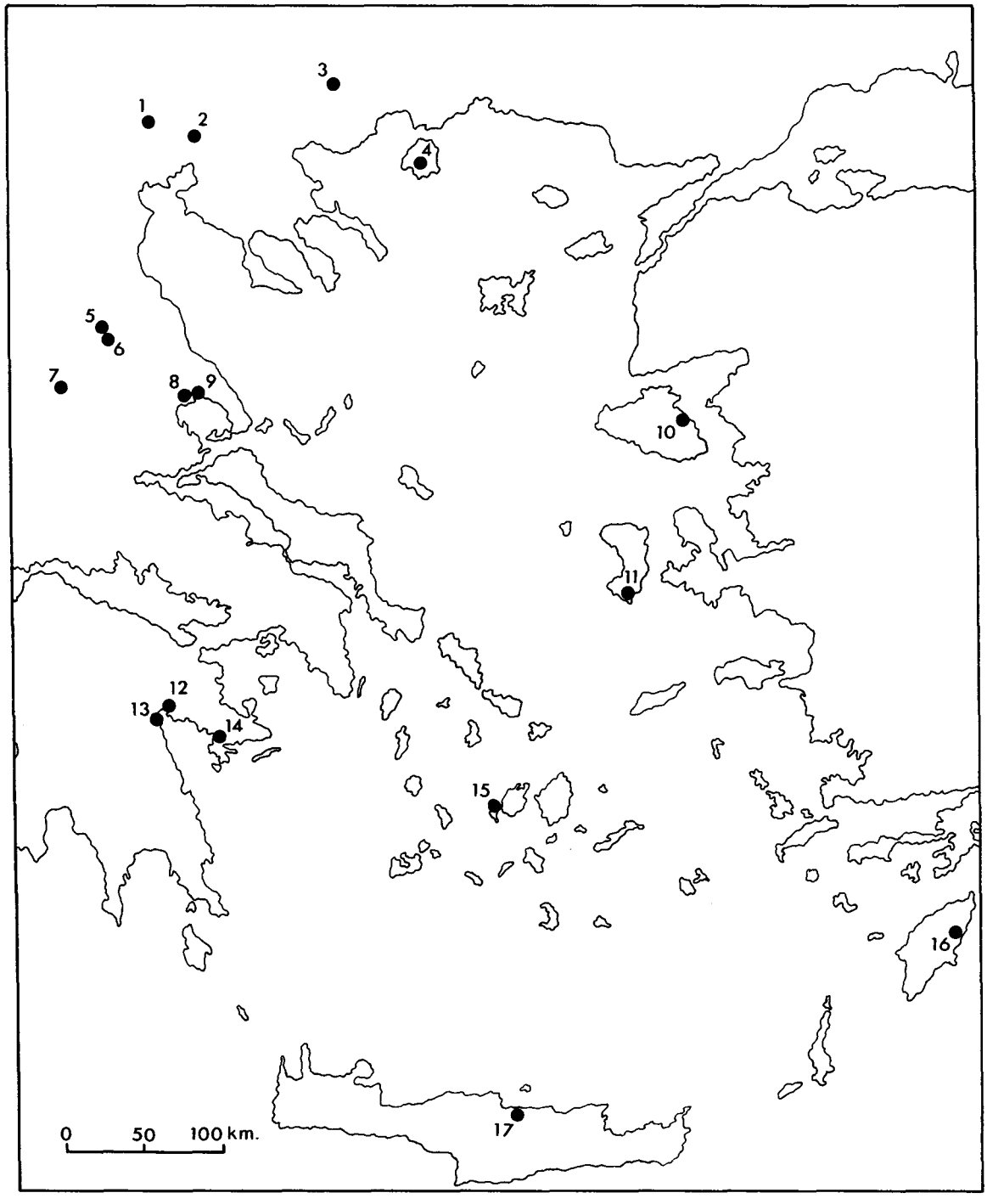

FIG. 1. The location of sites mentioned

Key: 1 Kastanas, 2 Assiros Toumba, 3 Sitagroi, 4 Theologos (cemetery)/Kastri (settlement), 5 Ayia Sofia, 6 Argissa, 7 Prodhromos, 8 Dhimini, 9 Pevkakia, 10 Thermi, 11 Emborio, 12 Tiryns, 13 Lerna, 14 Franchthi, 15 Saliagos, 16 Kalythies, 17 Knossos.

(*c.*6000 bc) and all of them must have been introduced by man at least in the case of island sites like Knossos on Crete.[8] Together these species dominate almost all Neolithic and Bronze Age faunal assemblages of any size.

Payne[9] has rightly cautioned against attempts, by the present author for one, to seek temporal or geographical trends in the relative proportions of these common farmyard animals, but the overwhelming predominance of sheep in Early Neolithic assemblages[10] can hardly be explained in terms of the known survival and recovery biases against small animals. In fact this pattern recurs right through the Balkan lowlands,[11] though not apparently into central Europe,[12] and is of some interest given that goat, cow, and pig were all better suited to the largely wooded natural environment of the time.[13]

The dog is also present at a low level throughout and isolated finds of horse and donkey bones are now becoming a regular occurrence in second and, to a lesser extent, third millennium bc contexts.[14] The introduction of the horse, which spreads at much the same time throughout Europe,[15] and of the donkey is discussed further below.

Of the larger 'wild' animals found alongside these domesticates, the aurochs (*Bos primigenius*), boar (*Sus scrofa*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), fox (*Vulpes vulpes*), badger (*Meles meles*), marten (*Martes foina*), wild cat (*Felis silvestris*), and hare (*Lepus europaeus*) were all found in Mesolithic levels at Franchthi[16] and wolf (*Canis lupus*), lynx (*Lynx lynx*), and bear (*Ursus arctos*) still survive in Greece today.[17] Though rare in the Neolithic, these species regularly make up a significant proportion of Bronze Age assemblages,[18] perhaps because progressive woodland clearance had increased their abundance, because introduction of the horse made the capture and transport of game easier or because of the growth of hunting as an aristocratic sport. At

[8] M. R. Jarman and H. N. Jarman, 'The Fauna and Economy of Early Neolithic Knossos', in J. D. Evans (ed.), 'Knossos Neolithic Part II', *BSA* 63 (1968) 241–64.

[9] Op. cit. (n. 4).

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

[11] R. Dennell, *Early Farming in Bulgaria from the VI to the III Millennia BC* (BAR Int. Series 45) (British Archaeological Reports 1978); K. Kosse, *Settlement Ecology of the Koros and Linear Pottery Cultures in Hungary* (BAR Int. Series 64) (British Archaeological Reports 1979); E. L. Sterud, 'Prehistoric Population of the Dinaric Alps: an Investigation of Inter-regional Interaction', in C. Redman, M. J. Berman, E. V. Curtin, W. T. Langhorne, N. M. Versaggi, and J. C. Wanser (eds.), *Social Archaeology: Beyond Subsistence and Dating* (Academic Press 1978) 381–408.

[12] P. Bogucki, *Early Neolithic Subsistence & Settlement in the Polish Lowlands* (BAR Int. ser. 150) (British Archaeological Reports 1982).

[13] E.g. S. Bottema, *Late Quaternary Vegetation History of Northwestern Greece* (Dissertation, University of Groningen 1974); 'Pollen Analytical Investigations in Thessaly (Greece)', *Palaeohistoria* 21 (1979) 19–40; 'Palynological Investigations in Greece with Specific Reference to Pollen as an Indicator of Human Activity', *Palaeohistoria* 24 (1982) 257–89.

[14] O. Bedwin, 'Appendix 2. The Animal Bones', in M. R. Popham, *The Unexplored Mansion at Knossos* (British School at Athens 1984) 307–8; J. Boessneck, 'Die Tierreste aus der Argissa-Magula vom präkeramischen Neolithikum bis zur mittleren Bronzezeit', in V. Milojčić, J. Boessneck, and M. Hopf, *Argissa-Magula 1: das Präkeramische Neolithikum sowie die Tier- und Pflanzenreste* (Rudolf Habelt 1962) 27–99; C. Gamble, 'The Bronze Age Animal Economy from Akrotiri: a Preliminary Analysis', in *Thera and the Aegean World* (Thera and the Aegean World 1978) 745–53; 'Animal Husbandry, Population and Urbanisation', in C. Renfrew and M. Wagstaff (eds.), *An Island Polity: the Archaeology of Exploitation in Melos* (Cambridge University Press 1982) 161–71; N.-G. Gejvall, *Lerna 1: the Fauna* (American School of Classical Studies 1969); P. Halstead and G. Jones, 'Appendix: Bio-Archaeological Remains from Assiros Toumba', in K. A. Wardle, 'Excavations at Assiros 1975–9', *BSA* 75 (1980) 265–7; B. Jordan, *Tierknochenfunde aus der Magula Pevkakia in Thessalien* (Dissertation, University of Munich 1975); H. Reichstein, 'Erste Ergebnisse von Untersuchungen an Tierknochen aus bronzezeitlichen Siedlungsschichten im nördlichen Griechenland (Ausgrabung Kastanas)', *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 26 (1979) 239–70; R. E. Sloan and M. A. Duncan, 'Zooarchaeology of Nichoria', in G. Rapp and S. E. Aschenbrenner (eds.), *Excavations at Nichoria in Southwest Greece, 1. Site, Environs, and Techniques* (University of Minnesota Press 1978) 60–77; J. P. N. Watson, 'Faunal Remains', in C. Ridley and K. A. Wardle, 'Rescue Excavations at Servia, 1971–1973: a preliminary report', *BSA* 74 (1979) 228–9.

[15] A. Sherratt, 'Plough & Pastoralism: Aspects of the Secondary Products Revolution', in Hodder, Isaac, and Hammond, op. cit. (n. 10) 261–305.

[16] Payne, op. cit. (n. 4).

[17] J. Ondrias, 'Die Säugetiere Griechenlands', *Säugetierkundliche Mitteilungen* 13 (1965) 109–27.

[18] E.g. Reichstein, op. cit. (n. 14) 244–6.

Bronze Age Lerna, the bones of wild animals were more fragmented than those of domestic stock,[19] suggesting more intensive use of their carcasses and so perhaps reflecting an emphasis on hunting in times of dearth.

These wild species are not indigenous at least to the more distant islands[20] and most island finds during the Neolithic and Bronze Age[21] can perhaps be explained away as the introduction of single animals or even just of skins or antler. (The isolated finds of lion bones at Tiryns[22] should probably be seen in the same light.) The distribution of fallow deer (*Dama dama*), however, is rather more interesting. This species seems to have been more or less absent from peninsula Greece during the Mesolithic, Neolithic, and Bronze Age, but is well represented alongside red deer and roe deer in Neolithic and Bronze Age Macedonia.[23] Fallow deer are now also widely attested at settlements of later Neolithic and Bronze Age date in the Aegean islands.[24] Some of these islands were joined to the Greek or Turkish mainland during the last Ice Age, and indeed perhaps until the beginning of the Neolithic,[25] but the existence of a potential parent population of fallow deer at this date is not yet demonstrated in either Turkey or mainland Greece. The possibility remains, therefore, that fallow deer were widely introduced to the Aegean islands by man, as they apparently were to Cyprus.[26]

This discussion leads on to the second question—how was each species managed? Firstly, why are deer referred to as wild, when it is suggested that they may have been deliberately introduced to the islands by man? The main reason for this is Garrard's important observation that wild sheep, goat, cow, and pig are all behaviourally pre-adapted to close-herding by man, whereas the territoriality and violent male conflicts of the deer make them quite unsuitable in this respect.[27] There is some archaeozoological confirmation that this different potential was realized. At Franchthi, shed milk teeth indicate that sheep and goats were closely herded in the cave from the earliest Neolithic onwards.[28] At Kalythies on Rhodes there is a clear contrast between sheep, goat, cow, and pig, represented by most body parts, and fallow deer, largely represented by the meaty upper limb bones (FIG. 2).[29] This suggests a real difference in management: the deer were hunted at a distance from Kalythies and only selected parts of the

[19] Gejvall, op. cit. (n. 14).

[20] E.g. M. D. Dermitzakis and P. Y. Sondaar, 'The Importance of Fossil Mammals in Reconstructing Palaeogeography with Special Reference to the Pleistocene Aegean Archipelago', *Annales Géologiques des Pays Helléniques* 29, 2 (1979) 808–40; P. Y. Sondaar, 'Paleozoogeography of the pleistocene mammals from the Aegean', in A. Strid (ed.), 'Evolution in the Aegean', *Opera Botanica* 30 (1971) 65–70.

[21] Bedwin, op. cit. (n. 14); J. P. Coy, 'Appendix 4: Animal Remains', in J. E. Coleman, *Keos I. Kephala* (American School of Classical Studies 1977) 129–33; Gamble, opp. citt. (1978; 1982, n. 14); M. R. Jarman, 'Human Influence in the Development of the Cretan Fauna' (Unpublished manuscript).

[22] J. Boessneck and A. von den Driesch, 'Ein Löwenknochenfund aus Tiryns', *AA* (1979) 447–9; 'Ein Beleg für das Vorkommen des Löwen auf der Peloponnes in "Herakleischer" Zeit', *AA* (1981) 257–8. Classical literary references do *not* document the presence of lions in Greece in historical times—J. Henderson, pers. comm.

[23] At Kastanas: Reichstein, op. cit. (n. 14); Assiros: Halstead and Jones, op. cit. (n. 14); Sitagroi: S. Bökönyi, 'Angaben zum frühholozänen Vorkommen des Damhirsches, *Cervus* (*Dama*) *dama* (Linné, 1758), in Europa', *Säugetierkundliche Mitteilungen* 19 (1971) 206–17; Bökönyi also cites earlier reports from Thrace.

[24] Neolithic Saliagos: Bökönyi, id.; Neolithic Kalythies, Rhodes: Halstead and Jones, op. cit. (n. 7); Neolithic and Bronze Age Kastri, Thasos: Halstead and Jones, 'The Fauna and Economy of Late Neolithic–Early Iron Age Kastri, Thasos' (in preparation); Bronze Age Thermi, Lesbos: W. Lamb, *Excavations at Thermi in Lesbos* (Cambridge University Press 1936); Bronze Age Emborio, Chios: J. Clutton-Brock, 'The Animal Bones', in S. Hood, *Excavations in Chios 1938–1955. Prehistoric Emporio and Ayio Gala II* (Supplementary Volume 16) (British School at Athens 1982) 678–97; Bronze Age Knossos, Crete: Jarman, op. cit. (n. 21).

[25] T. H. van Andel and J. C. Shackleton, 'Late Palaeolithic and Mesolithic Coastlines of Greece and the Aegean', *JFA* 9 (1982) 445–54.

[26] G. J. Boekschoten and P. Y. Sondaar, 'On the fossil Mammalia of Cyprus', *Koninklijke Nederlanse Akademie van Wetenschappen* B, 75 (1972) 306–38; J. P. N. Watson and N. P. Stanley-Price, 'The Vertebrate Fauna from the 1972 Sounding at Khirokitia', *RDAC* (1977) 232–60.

[27] A. N. Garrard, 'The selection of southwest Asian animal domesticates', in J. Clutton-Brock and C. Grigson (eds.), *Animals and Archaeology 3: Early Herders and their Flocks* (BAR Int. Series 202) (British Archaeological Reports 1984) 117–32.

[28] Payne, op. cit. (n. 4) 219.

[29] Halstead and Jones, op. cit. (n. 7).

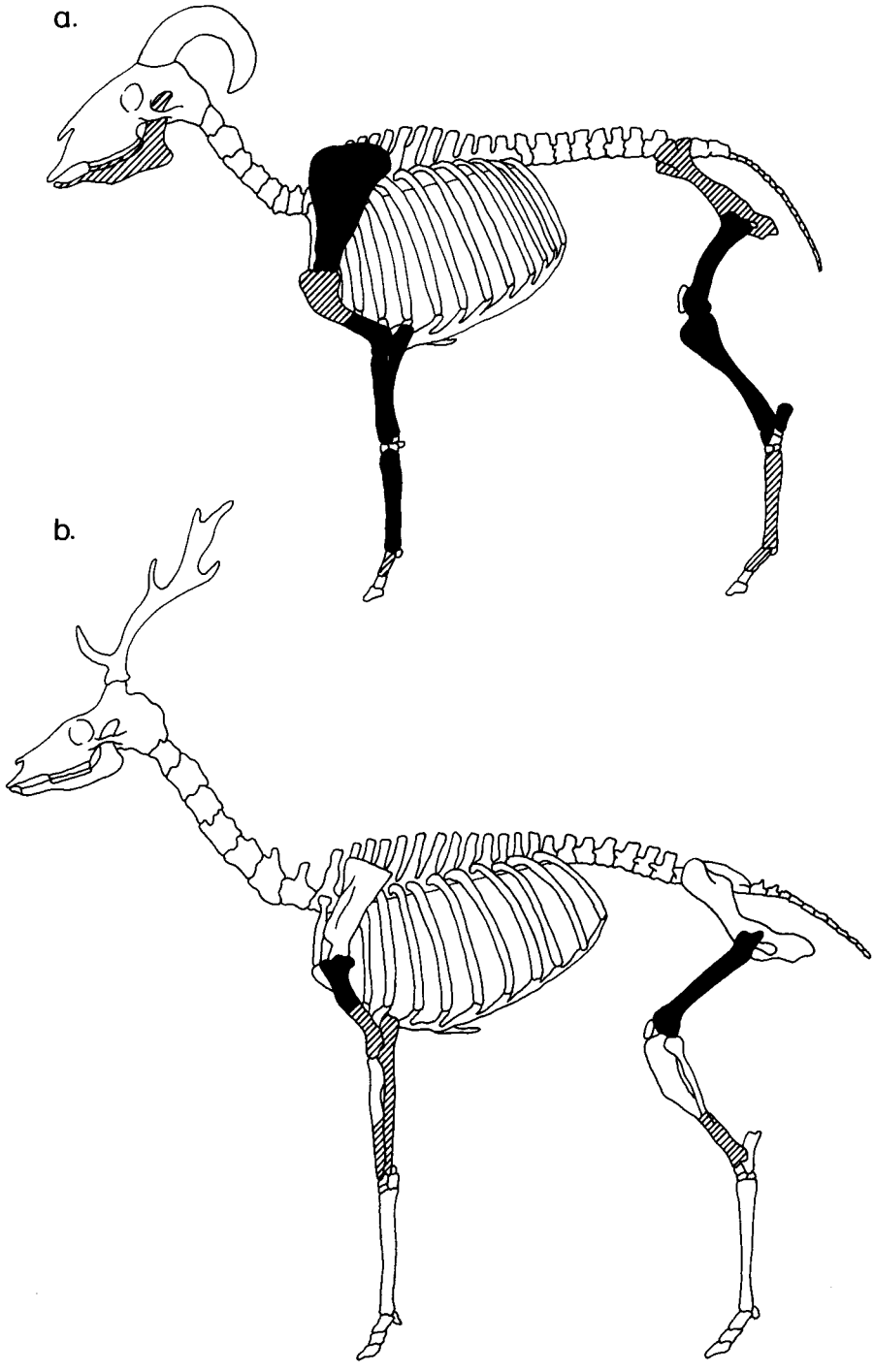

FIG. 2. The representation of different body parts of (*a*) sheep/goat and (*b*) fallow deer at Kalythies, Rhodes
Key: open 0–19%, hatched 20–39%, filled 40–100% of the commonest body part (for sheep/goat, distal humerus—136 fragments; for fallow deer, distal femur—29 fragments).

carcase were brought back to the cave; the common domesticates were closely herded so that the whole animal could be brought back to the cave on the hoof. There is as yet no such direct evidence from Greece for a difference in management between the wild and domestic populations of cattle and pigs, but that two distinct populations existed is suggested by the very variable size of the animals, and the rarer large specimens, which compare well with Mesolithic populations, are taken to be wild.[30]

Evidence for cut marks shows that most animals, domestic and wild, were eaten, including at least some dogs and horses.[31] Most of the bones of bear at Pevkakia and Dhimini in Thessaly, however, are from the foot[32] and so may well have been attached to skins, while the range of predatory birds at Pevkakia and Kalythies[33] could well have been taken simply for their feathers or talons.

Domestic livestock can of course be used for their secondary products as well as their meat. From the later Bronze Age there is a wealth of archival and artistic evidence for horses pulling chariots, for donkeys serving as pack animals, for pairs of oxen, for milking, and for the raising of sheep for wool on a massive scale.[34] The literature also abounds with claims that husbandry of cattle or sheep and goats for secondary products can be recognized on vague archaeozoological criteria, such as the presence of young or old animals.[35]

This approach has been put on a sounder footing by Payne.[36] On the basis of ethnographic observation of sheep and goat herding in Turkey, he presents explicit models of the pattern of mortality to be expected with each of three idealized management strategies. In flocks kept especially for milk, adult females are crucial to both milk production and herd reproduction and so most females are kept into adulthood and are only killed when their productivity falls off; most male lambs are surplus to requirements and so are killed off very young. If meat production is the objective, most females are still kept into adulthood as breeding stock but male lambs are killed off in their second or third year when they have grown to a reasonable size. Where wool is the objective, castrated males, which produce most wool, and breeding females are both maintained into adulthood. Of course animals are often kept for a mixture of purposes and it may also be difficult to decide whether actual mortality patterns diverge from these models because of different goals on the part of the herdsman or because of environmental constraints such as seasonal shortage of fodder. None the less, the sheep flocks documented in the Linear B archives of the palaces[37] correspond well with the wool model, while classic milk and meat patterns have been identified archaeozoologically for prehistoric cattle populations in temperate Europe.[38]

Direct comparison with Payne's models can also be attempted for a few archaeozoological sheep/goat assemblages from Greece. A group of assemblages from Neolithic and Bronze Age Thessaly diverges from all three ethnographic models in two respects (FIG. 3).[39] Firstly they do not

[30] E.g. K.-P. Amberger, *Neue Tierknochenfunde aus der Magula Pevkakia in Thessalien, 2. Die Wiederkäuer* (Dissertation, University of Munich 1979).

[31] E.g. Gejvall, op. cit. (n. 14); Sloan and Duncan, op. cit. (n. 14).

[32] Pefkakia: G. Hinz, *Neue Tierknochenfunde aus der Magula Pevkakia in Thessalien, 1. Die Nichtwiederkäuer* (Dissertation, University of Munich 1979); Dhimini: P. Halstead, 'The animal bones from late neolithic Dhimini' (in preparation).

[33] Pefkakia: Hinz, id.; Kalythies: Halstead and Jones, op. cit. (n. 7).

[34] E.g. J. Chadwick, *The Mycenaean World* (Cambridge University Press 1976) 126–33.

[35] E.g. S. Bökönyi, 'Stock Breeding', in D. R. Theocharis *Neolithic Greece* (National Bank of Greece 1973) 165–78; Sloan and Duncan, op. cit. (n. 14).

[36] S. Payne, 'Kill-off Patterns in Sheep and Goats: the Mandibles from Aşvan Kale', *AS* 23 (1973) 281–303.

[37] J. T. Killen, 'The Wool Industry of Crete in the Late Bronze Age', *BSA* 59 (1964) 1–15.

[38] A. J. Legge, 'The Agricultural Economy', in R. J. Mercer (ed.), *Excavations at Grimes Graves 1971–2* (Her Majesty's Stationery Office 1981) 79–118.

[39] P. Halstead, *Strategies for Survival: An Ecological Approach to Social and Economic Change in the Early Farming Communities of Thessaly, N. Greece* (Dissertation, University of Cambridge 1984) fig. 7.2. Source of data—Prodhromos: P. Halstead and G. Jones, 'Early neolithic economy in Thessaly—some evidence from excavations at Prodromos', *Ανθρωπολογικα* 1: 93–117; Dhimini: Halstead, op. cit. (n. 32); Ayia Sofia: A. von den

TABLE 1. *Sex ratio among sheep surviving beyond 6–10 months of age in Neolithic and Bronze Age Thessaly*

Assemblage	Nos. of pelves*	
	Female	Male
Early Neolithic Prodhromos 1–3	36	11
Late Neolithic Ayia Sofia	18	3
Late Neolithic Dhimini	11	2
Final Neolithic–Early Bronze 1 Pevkakia	28	1
Early Bronze 2 Pevkakia	4	5
Middle Bronze Age Pevkakia	18	14
Late Bronze Age Pevkakia	0	2
EN to FN–EB 1 total	93	17
EB 2 to LB total**	28	24

* With fused acetabulum.
** Including material from mixed EB 2/MB levels.

register natural infant mortality, perhaps because of the poor archaeological survival and recovery of infant bones. Secondly, most of them have rather few adult animals—perhaps because adult bones were broken up more than young ones during food preparation and discard, as was apparently the case with some body parts at Assiros Toumba in Macedonia.[40]

All of the archaeological assemblages approximate most closely to the meat model, with high levels of mortality between six months and three years of age. Indeed, given these high levels of juvenile mortality, the curves are unlikely to represent a specialized milk or wool strategy, concealed by the loss of infants through poor survival or of old animals through differential discard. For sheep, which predominate over goats throughout, the Neolithic assemblages have produced sex ratios which are heavily biased towards the survival of females (TABLE 1)[41]—as befits meat (or milk) production. The Bronze Age assemblages from Pevkakia suggest more even survivorship of the two sexes, so wool production may have been more important, though not to the extent of causing a change in age structure.

The evidence from Thessaly suggests that the herding strategy for sheep/goats came nearer to optimizing for potential meat than for milk or wool production, but of course this does not mean that meat only was produced[42]—as Payne himself observes,[43] most flocks are kept for a variety of purposes. Alternatively, milk and meat production can usefully be construed as different means to achieving goals such as energy capture or herd security.[44] Where grazing is not limiting,

Driesch and K. Enderle, 'Die Tierreste aus der Agia Sofia-Magoula in Thessalien', in V. Milojčić, A von den Driesch, K. Enderle, J. Milojčić-v. Zumbusch, and K. Kilian, *Die Deutschen Ausgrabungen auf Magulen um Larisa in Thessalien, 1966* (Rudolf Habelt 1976) 15–54; Pevkakia: Amberger, op. cit. (n. 30); Jordan, op. cit. (n. 14). Fourth and third millennium bc culture history in Thessaly poses some complex terminological and chronological problems. 'Final Neolithic–Early Bronze 1' and 'Early Bronze 2' here refer to material called 'Rakhmani' and 'Early Bronze Age' by Amberger and Jordan, and probably date respectively to the early fourth to mid-third millennia bc and mid-third to early second millennia bc (Halstead, id., 1984).

[40] P. Halstead and G. Jones, 'Faunal remains and animal exploitation at Assiros Toumba' (in preparation).

[41] Halstead, op. cit. (n. 39) table 7.4. For sources of data, see n. 39.

[42] e.g. R. Cribb, 'The analysis of ancient herding systems: an application of computer simulation in faunal studies', in G. Barker and C. Gamble (eds.), *Beyond Domestication in Prehistoric Europe* (Academic Press 1985) 75–106.

[43] Op. cit. (n. 36).

[44] R. W. Redding, *Decision Making in Subsistence Herding of Sheep and Goats in the Middle East* (Dissertation, University of Michigan 1981); 'Theoretical determinants of a herder's decisions: modeling variation in the sheep/goat ratio', in Clutton-Brock and Grigson, op. cit. (n. 27) 223–41.

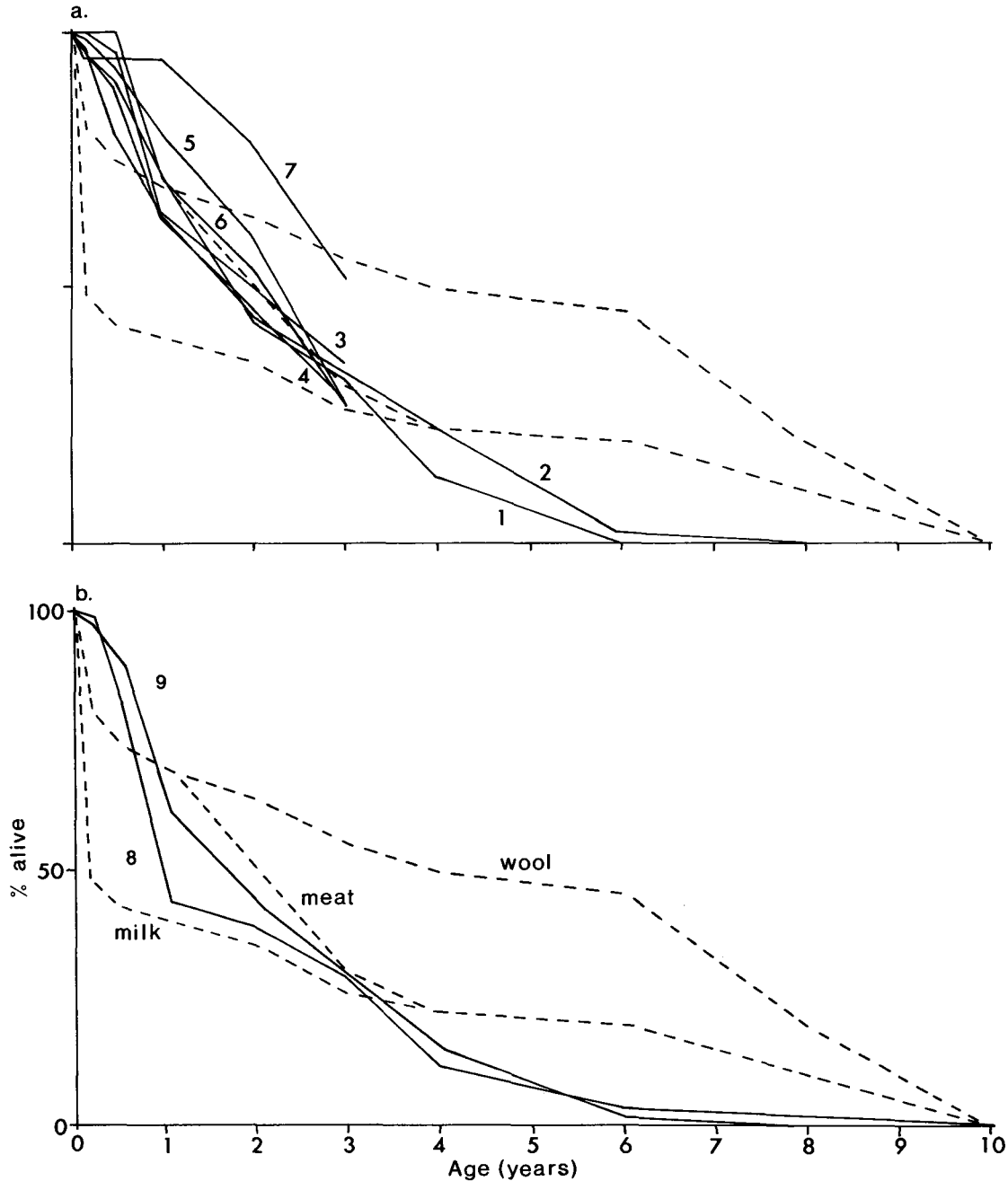

FIG. 3. The survivorship of sheep/goat: comparison of Payne's models with archaeological material from (*a*) Thessaly and (*b*) Thasos

Key: dashed lines—Payne's models; solid lines—archaeological assemblages (mandibles). 1 Early Neolithic Prodhromos (68), 2 Late Neolithic Dhimini (107), 3 Late Neolithic Ayia Sofia (66), 4 Final Neolithic–Early Bronze 1 Pevkakia (159), 5 Early Bronze 2 Pevkakia (100), 6 Middle Bronze Age Pevkakia (136), 7 Late Bronze Age Pevkakia (39), 8 Late Neolithic Kastri (95), 9 Early Iron Age Kastri (48). Because of disparities of method, the older age classes from Ayia Sofia and Pevkakia cannot be compared with Payne's models. *N.B.* the unusual Late Bronze Age curve from Pevkakia is based on only 39 mandibles.

Payne's meat strategy achieves the greatest productivity in terms of energy: in addition to surplus milk from breeding females, young males killed at 2–3 years of age provide a substantial amount of meat.[45] If grazing is strictly limited, on the other hand, the maintenance of young males to this age would entail a corresponding reduction in the number of breeding females, and in this case Payne's milk strategy would yield more energy. In the wooded environment of prehistoric Thessaly, therefore, where *accessible* grazing was limited and extensive herding difficult,[46] the husbandry of sheep/goats was evidently not geared to maximization of energy capture. Herd security is best served by keeping animals in the prime of life, but not engaged in breeding, as they are least vulnerable to disease, predation, or nutritional stress. The herding strategy characteristic of Neolithic Thessaly, therefore, offered a compromise between energy productivity and security, while the improvement in male survivorship in the Bronze Age suggests increasing emphasis on wool and/or herd security at the expense of energy productivity.

Preliminary results from Late Bronze and Early Iron Age Assiros Toumba in Macedonia again suggest a broadly 'meat' strategy, with females surviving better than males,[47] and so contrast with the archival emphasis on wool production in Southern Greece and the archaeozoological hint of the same in Thessaly. The Late Neolithic assemblage from Kastri on Thasos, however, shows a rather steeper juvenile kill-off than any seen yet (FIG. 3).[48] The sharp kill-off in the first year, followed by a secondary peak after two years of age, is consistent with a mixed milk/meat strategy. The very early mortality peak characteristic of specialized milk production is not represented, but a steady kill-off through the first year suggests that this is not simply a meat strategy constrained by an environment with a severe seasonal shortage of grazing. A mixed milk/meat strategy achieving a high level of energy production is perhaps a more likely interpretation. By contrast, the Early Iron Age assemblage from Kastri again suggests a meat strategy.

Comparable mortality curves for other sites and for other species cannot be constructed because of insufficient or inadequate data, but the heavy late juvenile/early adult slaughter characteristic of the meat model is apparent among the sheep/goat from Neolithic Knossos on Crete, Neolithic and Bronze Age Lerna in the Peloponnese and Argissa in Thessaly and likewise among the cattle from Neolithic Knossos and Bronze Age Lerna.[49] Similarly, the cattle from Bronze Age Pevkakia imply a meat or mixed meat/traction strategy rather than specialized milk production, while the small sample of sexable cattle bones from Pevkakia and from Late Neolithic Ayia Sofia hints at an improvement in male survivorship in Thessaly during the third and second millennia bc (TABLE 2)[50]—at a time when the use of oxen for ploughing or pulling carts is widely documented in Europe and the Near East.[51] The mortality patterns of pigs, which offer no secondary products, invariably suggest meat production.

In turning to the third question—what was the role of animal husbandry in the overall economy?—we must move beyond the patchy, partial, and biased evidence of excavated faunal remains and consider the costs and benefits of some alternative model subsistence strategies. In most parts of lowland Greece, cultivated plants will have been far more productive per unit area as a staple resource than animal products.[52] Domestic livestock raised for milk are in turn vastly more productive per unit area, albeit at a high cost in human labour, than those raised for

[45] Redding, op. cit. (1981, n. 44).
[46] Halstead, op. cit. (n. 10).
[47] Halstead and Jones, op. cit. (n. 40).
[48] Halstead and Jones, op. cit. (n. 24).
[49] Knossos: Jarman and Jarman, op. cit. (n. 8); Lerna: Gejvall, op. cit. (n. 14); Argissa: Boessneck, op. cit. (n. 14).
[50] Halstead, op. cit. (n. 39) table 7.6. For sources of data, see n. 39.
[51] Sherratt, op. cit. (n. 15).
[52] Halstead, op. cit. (nn. 10, 39).

TABLE 2. *Sex ratio among cattle surviving beyond* c. *24–36 months of age in Neolithic and Bronze Age Thessaly*

Assemblage	Nos. of metapodials*	
	Female	Male
Late Neolithic Ayia Sofia	4	0
Final Neolithic–Early Bronze 1 Pevkakia	12	1
Early Bronze 2 Pevkakia	18	14
Middle Bronze Age Pevkakia	19	9
Late Bronze Age Pevkakia	7	5
LN to FN–EB 1 total	16	1
EB 2 to LB total**	52	32

* With fused distal epiphysis.
** Including material from mixed EB 2/MB levels.

meat,[53] while hunting will usually have offered far less potential than herding. The opportunities for gathering significant quantities of wild plant foods were very uneven, both in time and space, and Gallant has recently shown that the fishing technology of antiquity was ill-equipped to exploit the modest marine resources of the Mediterranean.[54] In short, with increasing size, human communities are faced with an increasingly narrow range of viable subsistence strategies: small, dispersed populations may survive in Greece by hunting and gathering wild resources, but larger communities are increasingly restricted to extensive herding for meat, then intensive dairying, and ultimately crop agriculture. There are quite large communities today in Greece which are to some extent dependent for their livelihood on herding or fishing, but they sell their produce in the market and buy in relatively cheap agricultural foodstuffs. Moreover, those dependent on herding have specialized in highly productive dairy economies.[55]

The village communities characteristic of earlier Neolithic settlement in mainland Greece and central Crete[56] presumably lacked markets and they concentrated on a relatively unproductive meat strategy of stock husbandry. By virtue of their size, therefore, these communities must largely have depended on crop plants for their basic subsistence. Moreover, concentration on sheep rather than on cattle, goats, or pigs meant that little use could be made of the extensive woodland and so suggests that stock were few in number, largely restricted to the agricultural land. Here the efficiency of sheep in converting stubble and fallow fields to manure[57] must have contributed to the maintenance of soil fertility and so to the remarkable longevity of many early farming villages.[58] Meat and milk could also have provided an alternative food supply in times of crop failure[59] and the unproductive, but low risk, meat strategy of husbandry was advantageous in this respect.

This pattern of early farming villages dependent on agriculture was widespread in the

[53] E.g. Legge, op. cit. (n. 38).

[54] T. W. Gallant, *A Fisherman's Tale: an Analysis of the Potential Productivity of Fishing in the Ancient World* (MIGRA fascicle 7) (University of Gent 1985).

[55] E.g. J. K. Campbell, *Honour, Family and Patronage* (Oxford University Press 1964).

[56] Halstead, 'From Determinism to Uncertainty: Social Storage and the Rise of the Minoan Palace', in A. Sheridan and G. Bailey (eds.), *Economic Archaeology: towards an Integration of Ecological and Social Approaches* (BAR Int. Series 96) (British Archaeological Reports 1981) 187–213.

[57] J. F. H. Thomas, *Sheep*[3] (Faber and Faber 1957).

[58] Cf. Dennell, op. cit. (n. 11).

[59] K. V. Flannery, 'Origins and ecological effects of early Near Eastern domestication', in P. J. Ucko and G. W. Dimbleby (eds.), *The Domestication of Plants and Animals* (Duckworth 1969) 73–100.

Balkans, where the crops were well adapted to the environment. Only as farming economies expanded into the lower Alpine valleys[60] and perhaps onto the north European plain[61]—environments to which crops of Near Eastern or Mediterranean origin would initially have been ill-adapted—were livestock for a time the subject of highly productive, specialized dairying. Presumably animals played a more prominent role in normal subsistence where crop production was less reliable and the subsequent abandonment of specialized dairying in the lower Alpine valleys during the Bronze Age reflects better adaptation of crops (or crop husbandry) to the local environment.

During the later Neolithic and earlier Bronze Age in Greece, settlement expanded to the smaller Aegean islands[62] and also filled in some of the agriculturally more marginal parts of the mainland.[63] In each case, the expansion took the form of small hamlets or isolated farmsteads and this new dispersed settlement strategy widened the range of viable subsistence options. On the islands, fallow deer were perhaps introduced to supplement the impoverished indigenous wild faunas and on Thasos a productive, mixed milk/meat herding strategy for sheep/goat may have been pursued to supplement the meagre potential for arable farming. As in the lower Alpine valleys, this reliance on specialized dairying may have been quite short-lived.

At varying stages during the Bronze Age, both the early farming villages and the later dispersed communities aggregated into a few large, nucleated settlements. Nucleation forced farmers to cultivate more distant land and so greatly increased the labour costs of agriculture. It is at this stage, with the widespread introduction of the horse and donkey and the hint of traction oxen at Pevkakia, that animal muscle power may first have become important.[64] Work animals represent a considerable capital investment, as is apparent from both ethnographic and historical accounts of Mediterranean rural economy,[65] and the fact that the oxen controlled by the palace at Knossos were few enough to be recorded by name[66] suggests that the same was true in prehistory. Restricted access to scarce work animals and to expensive status items like chariot teams may thus have helped to consolidate the power of the elite groups which emerged during the Bronze Age.

Nucleation also greatly increased the costs of animal husbandry and may have occasioned a shift from small-scale herding by individual households to the collective herding of large consolidated flocks, common today.[67] A possible hint of such a change in flock management comes from Pevkakia in Thessaly, where the Early Bronze Age period of settlement nucleation saw a marked improvement in the survivorship of male sheep (TABLE 1), apparently without any corresponding improvement in overall survivorship (FIG. 3). This suggests that proportionately more female lambs were killed off, perhaps because of economies of scale afforded by larger flocks: a few female lambs must always be kept in reserve in case breeding females are lost or fail to lamb,[68] but in a large, consolidated flock these reserve females would make up only a small proportion of the total and so enable more male lambs to be kept alive.

One consequence of larger flocks may have been to make worthwhile, for the first time, the

[60] Legge, op. cit. (n. 38).

[61] Bogucki, op. cit. (n. 12); 'Ceramic sieves of the Linear Pottery Culture and their economic implications', *Oxford Journal of Archaeology* 3 (1984) 15–30.

[62] J. F. Cherry, 'Pattern & Process in the Earliest Colonization of the Mediterranean Islands', *PPS* 47 (1981) 41–68.

[63] P. Halstead, 'Prehistoric Thessaly: the Submergence of Civilisation', in J. L. Bintliff (ed.), *Mycenaean Geography* (British Association for Mycenaean Studies 1977) 23–9; op. cit. (n. 56).

[64] C. Gamble, 'Surplus and Self-Sufficiency in the Cycladic Subsistence Economy', in J. L. Davis and J. F. Cherry (eds.) *Papers in Cycladic Prehistory* (Institute of Archaeology Monograph 14) (University of California, Los Angeles 1979) 122–34; Halstead op. cit. (n. 10).

[65] E.g. D. Christodoulou, *The Evolution of the Rural Land Use Pattern in Cyprus* (World Land Use Survey Regional Monograph 2) (Geographical Publications 1959) 182–3; K. D. White, *Roman Farming* (Thames and Hudson 1970).

[66] Chadwick, op. cit. (n. 34) 127.

[67] P. Halstead, 'Traditional and Ancient Mediterranean Rural Economy: Plus ça Change?' *JHS* 107 (1987).

[68] Payne, op. cit. (n. 36).

seasonal use of areas of upland summer pasture,[69] and it has been argued that the 'peak sanctuaries' which sprang up in Crete at the beginning of the Middle Bronze Age, again at a time of settlement nucleation, are related to such usage.[70] Another consequence of consolidated flocks would be to make livestock more vulnerable to elite control and the sheep recorded in the Late Bronze Age archives at Knossos (which provide the first unambiguous evidence for large flocks) were certainly under the control of the palace.[71]

Nucleation also narrowed the range of available subsistence options, both in normal years and in times of famine. This will have enhanced the importance of domestic livestock as a source of food in times of crop failure[72] and so we may perhaps envisage the elite adding control of this back-up food supply to its monopoly of work animals used in normal food production. As such a walking food bank, the sheep is particularly attractive because of the way in which it stores fat[73] and of course it also provides a fleece every time slaughter is deferred for a further year. Selection of wethers, or castrated males, enhances both flock security and wool production—and the wool can be converted to textiles and then exchanged to accumulate food surpluses.[74] It has been argued elsewhere[75] that the origin of the massive state interest, perhaps even monopoly, in sheep raising and wool production, documented in the Late Bronze Age Linear B archives, may well lie in such a system of banking on sheep.

Clearly, as this review has progressed, it has been treading on increasingly thin archaeozoological ice, but it should at least have established that the answers to some important questions do lie within our grasp. It is to be hoped that the appetite of Aegean prehistorians has been whetted, because the moral of this attempted synthesis lies in its implications for the future. For certain areas, periods, and types of site we can still benefit from the sort of modest faunal assemblages which are now becoming reasonably commonplace. But to determine in detail and with confidence how animals were managed, we need some massive assemblages, rigorously recovered and with high quality contextual information.

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[69] Such seasonal use of upland pasture reflects not the *absence*, but the *scarcity*, of lowland summer grazing and so may not have been usual until fairly large numbers of livestock were maintained. Moreover, much of the present-day upland pasture, particularly in northern Greece, is the product of human interference. Similarly, in the relatively wooded lowland landscape which preceded extensive clearance by man, there will have been less available winter grazing and more summer browse than in recent times. Thus three key elements of modern seasonal pastoral movements—a surfeit of lowland winter grazing, a surfeit of upland summer grazing and a large overall population of domestic livestock—may not have pertained throughout much of prehistory (cf. Halstead, op. cit. (n. 67)).

[70] B. Rutkowski, *Cult Places in the Aegean World* (Polish Academy of Sciences 1972); J. F. Cherry, 'Generalization and the Archaeology of the State', in D. Green, C. Haselgrove, and M. Spriggs (eds.), *Social Organisation and Settlement: Contributions from Anthropology, Archaeology and Geography* (BAR Int. Series 47) (British Archaeological Reports 1978) 411–37; K. Branigan, 'Minoan Settlements in East Crete', in P. J. Ucko, R. Tringham, and G. W. Dimbleby (eds.), *Man, Settlement and Urbanism* (Duckworth 1972) 751–9.

[71] Killen, op. cit. (n. 37).

[72] Halstead, op. cit. (n. 56).

[73] G. Dahl and A. Hjort, *Having Herds: Pastoral Herd Growth and Household Economy* (Stockholm Studies in Social Anthropology 2) (University of Stockholm 1976); Redding, op. cit. (1984, n. 44).

[74] Cf. J. O'Shea, 'Coping with Scarcity: Exchange and Social Storage', in Sheridan and Bailey, op. cit. (n. 56) 167–83.

[75] Halstead, op. cit. (n. 56); P. Halstead and J. O'Shea, 'A friend in need is a friend indeed', in C. Renfrew and S. Shennan (eds.), *Ranking, Resource & Exchange* (Cambridge University Press 1982) 92–9.