FROM RECIPROCITY TO REDISTRIBUTION : MODELLING THE EXCHANGE OF LIVESTOCK IN NEOLITHIC GREECE

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Summary

Archaeozoologists face severe problems in the recognition of reciprocal exchanges of livestock over short-distances, such as may have prevailed among earlier farming communities. This paper adopts an indirect approach to modelling reciprocal exchanges of livestock between early farmers in Greece. Agricultural production was organised at a household level but, given the limitations of the household labour force, demographically viable populations of livestock can have existed only at a village or regional level. Livestock must, therefore, have been regular objects of exchange between households. This phenomenon is interpreted in the light of the highly flexible role of livestock in indirect storage among recent farmers in Greece. In conclusion, the transformation of neolithic inter-household reciprocity in livestock into the centralised redistribution of the late bronze age palaces, with its particular emphasis on sheep raising and wool production, is briefly considered.

Résumé

De la réciprocité à la redistribution : modélisation des échanges de bétail en Grèce néolithique.

L'archéozoologie éprouve de grandes difficultés à déceler les échanges réciproques de bétail réalisés sur de courtes distances, tels que ceux qui étaient probablement les plus fréquents dans les premières sociétés agro-pastorales. Cet article opte pour une voie indirecte de modélisation des échanges réciproques de bétail entre les premiers groupes agro-pastoraux de Grèce. La production agricole était organisée au niveau de la maisonnée mais, compte tenu des forces de travail limitées qu'offre cette structure, les troupeaux démographiquement viables ne pouvaient guère exister qu'au niveau d'un village ou d'une région. Il devait donc y avoir des échanges réguliers de bétail entre les maisonnées. Ce phénomène est interprété à la lumière du rôle extrèmement varié du bétail dans le stockage indirect que pratiquent les sociétés agro-pastorales grecques modernes. En conclusion, l'auteur examine rapidement le passage de la réciprocité inter-maisonnées du Néolithique à la redistribution centralisée des palais du Bronze final, avec l'importance qu'elle accordait à l'élevage du Mouton et à la production de laine.

Key Words

Exchange, Livestock, Storage, Greece, Neolithic

Mots clés

Echanges, Bétail, Stockage, Grèce, Néolithique

Introduction

Archaeological recognition of the exchange of foodstuffs is notoriously problematic. Problems of inference are particularly acute in the case of exchanges over short distances, in which plant or animal taxa do not move outside their ecological range (cf. ARMITAGE and McCARTHY, 1980 ; WILCOX, 1977), and in the case of reciprocal exchanges, which are unlikely to create distinctive spatial patterns of anatomical or demographic representation (cf. MALTBY, 1985 : 62-66 ; JONES, 1985 ; CRIBB, 1985). Using neolithic Greece as a case study, this paper suggests an indirect approach to the investigation of reciprocal exchanges of livestock and considers the wider implications of such exchanges.

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Farming and livestock in neolithic Greece

Early agricultural settlement in Greece is typified by closely-spaced villages of perhaps 50-300 inhabitants. A range of cereal and pulse grain crops was grown and the full complement of neolithic livestock was kept - sheep, goat, cow and pig. The size of the village communities, the absence of evidence for intensive dairying and the constraints imposed on large-scale herding by a more or less well-wooded landscape together suggest that grain crops were the principal dietary staples of the early farming population, providing the overwhelming bulk of calorific requirements (HALSTEAD, 1987a, 1989a). Livestock doubtless contributed to the nutritional balance and palatability of the diet and probably played an important role in maintaining soil fertility.

Models of this early farming economy have treated the individual settlement as the unit of analysis (e.g. HALSTEAD, 1981). As in the Near East and Mesoamerica (FLANNERY, 1972), however, architectural evidence from neolithic Greece suggests that a family household, whether nuclear or extended, was literally walled off as the basic unit of residence, production and consumption (HALSTEAD, 1989b). This interpretation of neolithic architecture is supported by the cross-cultural contrast in habitation density between the settlements of recent gatherer-hunters not practising storage and those of gatherer-hunters and farmers dependent on storage (FLETCHER, 1981). The crowded settlements of the former help residents to monitor food consumption and so to maintain social pressure for sharing (WHITELAW, 1983a). Conversely, the more spacious settlements of the latter, with their internal architectural segregation, facilitate the hoarding of food by individual households while promoting sharing within the household.

The food production strategies of individual households in neolithic Greece have not been investigated (*pace* HOURMOUZIADHIS, 1979 ; WHITELAW, 1983b), and indeed most archaeobotanical and archaeozoological data come from small-scale sondages primarily designed to explore the vertical rather than horizontal structure of sites. Stores of at least three grain crops (einkorn, lentil and grass pea) in a middle neolithic house destroyed by fire at Servia (HUBBARD, 1979) suggest storage and at least a degree of crop diversification at a domestic level. At late neolithic Dhimini, much of the settlement has been exposed and a series of domestic areas has been recognised, separated by yard-walls (HOURMOUZIADHIS, 1979). Here the remarkably constant representation of sheep, goat, cow and pig, not only in each domestic area but also in each of their constituent architectural units (HALSTEAD, in press a), suggests that each household raised or at least consumed the full range of neolithic livestock. The same conclusion is suggested by the presence of a range of domesticates in individual deposits or successive levels from small soundings at early neolithic Argissa and Otzaki (BOESSNECK, 1962 : 60 tab. 3, 1955 : 5 tab. 2). At best these soundings usually expose only parts of one or two houses and so would be expected to produce a less constant faunal record, if individual households only kept and consumed part of the spectrum of neolithic livestock. Clearly the possibility of domestic subsistence specialisation warrants further investigation, but available evidence suggests that neolithic households (like recent farming households in Greece - FORBES, 1982) practised subsistence diversification. The maintenance of a mixed herd of livestock at a domestic level, however, may present a practical problem - the number of animals needed to ensure a viable herd may exceed the capacity of the household labour force.

Exploring the size and viability of household herds

It will be assumed for heuristic purposes that livestock in neolithic Greece was indeed managed at a household level. If each newly established household was provided with livestock by inheritance, gift, loan etc., but thereafter received no further stock during a standard generation cycle of 25 years, the numbers of sheep, goats, cattle and pigs necessary to ensure a viable household herd can be estimated in three ways.

(1) To maintain genetic diversity, even in the short term, and so avoid the dangers of "inbreeding depression" (reduced birth rate, increased infant mortality and lower proportion of female calves), a minimum effective breeding population of 50 individuals per species has been recommended (FRANKLIN, 1980 ; SENNER, 1980 ; SOULE, 1980). Given the strikingly uneven adult sex ratio among neolithic livestock in Greece (HALSTEAD, 1987a), an effective breeding population of 50 would have been equivalent to a substantially larger actual population (e.g., with a 6 :1 sex ratio, c. 100 adults) and, because of

variable "family size", the minimum breeding population would probably have been particularly large for pigs (cf. FRANKLIN, 1980 : 139). On the other hand, unless individual households kept their livestock in complete isolation (i.e. prevented females at pasture from being mated by the male stock of other households), the breeding population may in practice have been the combined herds of the whole village (or even of several neighbouring villages). In other words, short-term genetic diversity could well have been maintained with extremely small household herds.

(2) Rather larger household herds would have been needed for each household to maintain a demographically viable breeding population, because of the stochastic risks that any individual breeding female might die "prematurely", prove infertile or repeatedly bear male offspring. If it is assumed, for the sake of simplicity, that birth rate (λ) and death rate of livestock were equal, the probability of extinction (P_0) for a population of a given initial size (i) during a given number of years (t) can be estimated (PIELOU, 1969 : 17) as

$$P_0 = \left(\frac{\lambda t}{1+\lambda t}\right)^{i.}$$

If each (female) cow between the ages of two and ten years produced a calf annually (i.e. $\lambda = 0.45$), a household would thus have needed 27 cattle to reduce the risk of extinction to 10 per cent (one in ten) over a single generation of 25 years (for demographic parameters of cattle, see DAHL and HJORT, 1976 ; also ENTWISTLE and GRANT, 1989 ; LEGGE, 1989). If the period of household self-sufficiency was longer than 25 years, or the degree of risk deemed acceptable was lower, then of course the required number of cattle would be larger (e.g. 32 head for 10 per cent risk over 30 years ; 39 or 52 head for 5 per cent or 2 per cent risk over 25 years). If the birth rate and death rate were lower (but still equal), then a smaller number of cattle would be implied : e.g. with only 80 per cent calving by cows aged 4-10 years ($\lambda = 0.28$), 17 head would be required for 10 per cent risk over 25 years. In this case, however, the assumption that birth rate balanced death rate would be less reasonable, because conditions favouring low fertility might also favour high mortality, and herd size might have to be expanded in compensation.

The suggested minimum of 27 cattle/household includes both males and females and so could be nearly halved if the necessary pool of breeding males was maintained at a village level, as suggested above. The maintenance of too few sexually mature males could have left some adult females barren, however, and could have led to inbreeding depression, so undermining demographic viability. Moreover, although fewer male than female cattle survived until adulthood at late and final neolithic Ayia Sofia and Pevkakia (HALSTEAD, 1987a : 81 tab. 2), there is no evidence that most male calves were killed during infancy. A modest reduction in minimum herd size to, say, 20 individuals (i.e. including a few young males) may be appropriate.

It might be more realistic to assume that birth rate exceeded *natural* death rate and that households selectively slaughtered surplus animals to avoid an unwanted increase in herd size. The stochastic loss of key breeding females could then have been corrected by avoiding the slaughter of female calves. The combination of natural mortality (which will have tended to remove the youngest and oldest individuals) and of selective slaughter (which apparently concentrated on juveniles and young adults - e.g. BÖKÖNYI, 1989) may have approximated to the stochastic model adopted above. By manipulating the slaughter of female livestock, households probably could have reduced still further the minimum viable size of household herd, but in practice calves are subject to high natural mortality and take at least two years to reach sexual maturity. Households may have been slow to correct losses of breeding cows, therefore, and so vulnerable to a spiral of declining herd size - unless they maintained additional females of breeding age in reserve. Since the parameters adopted here are otherwise rather optimistic, a minimum herd size of 20 cattle may be retained.

For pigs, a large litter size and the possibility of farrowing twice or even three times per year make possible a far higher birth-rate (LAUWERIER, 1983 ; BIDDICK, 1984). Even with a conservative estimate of birth-rate (say $\lambda = 3.0$), and again assuming that birth rate and death rate are equal, to ensure only a 10 per cent risk of extinction over 25 years would require c. 170 pigs or perhaps c. 100 if cross-breeding between household herds allowed most male stock to be slaughtered young. The minimum numbers required for sheep and goats will have been intermediate between those for cattle and pigs.

(3) Each household must have kept enough head of each species to produce the relative proportions of domestic livestock implied by faunal evidence. In assemblages from late neolithic villages, the four domesticates may be relatively evenly represented, but early neolithic assemblages are dominated by sheep (tab. 1). In the three largest early assemblages (Achilleion, Argissa and Knossos), bones of sheep/goat make up 65-85 per cent of domesticates and, among specimens identifiable more closely, sheep strongly outnumber goats ; domestic pigs make up c. 10-15 per cent and cattle c. 5-15 per cent. Since all these assemblages have been collected "by hand", without sieving, recovery will have been heavily biased in favour of cattle, the largest species (PAYNE, 1972, 1985). Pre- and post-depositional processes have not been examined in detail, but marrow extraction may have exaggerated "fragments" counts of cattle bones (cf. BINFORD, 1978), while destruction by dogs will have biased survival in favour of the larger bones of cattle (PAYNE and MUNSON, 1985). In short, cattle may well have contributed substantially less than 5 per cent of the bones originally discarded on these village sites and, if these bones were representative of deaths among livestock, then at least 20 smaller domesticates (say 10 sheep, 5 goats and 5 pigs) were probably killed for every early neolithic cow slaughtered. To convert such proportions of deadstock to livestock requires more detailed information than is presently available on the survivorship patterns of each species. Given differences in generation time, live cattle might be somewhat *under*-represented among deadstock in comparison with sheep, goats and, in particular, pigs. On the other hand, neolithic management of all four domesticates seems to have been characterised by a high level of juvenile mortality (HALSTEAD, 1987a) and, at early-middle neolithic Achilleion, juvenile mortality may have been higher for cattle than for sheep and goats (BÖKÖNYI, 1989 : 323 tab. 13.8). In addition to 20 cattle, therefore, a viable herd would have included at least 400 or so smaller stock.

If the same line of reasoning is pursued for pigs, the 10-20 per cent representation in unsieved faunal assemblages is probably a considerable underestimate of the contribution of pigs to bones originally discarded. Conversely, live pigs may be somewhat *over*represented in the death assemblage in comparison with sheep/goats, which tend towards a rather older pattern of survivorship. If as many as 100 pigs were required for demographic viability, therefore, a viable household herd would have included several hundred sheep and goats.

Taking (2) and (3) together, the implication is that a demographically viable herd of an early neolithic household would have included at least 20 cattle, 100 pigs and several hundred ovicaprids, principally sheep. Flocks of several hundred sheep have been run by transhumant shepherds in Greece in the recent past, but have drawn on the labour of several households (usually free of arable farming commitments) and have required access to large, consolidated blocks of upland summer grazing and lowland winter pasture (CAMPBELL, 1964 ; KOSTER, 1977). Such blocks of pasture are unlikely to

Table 1 : Representation of sheep, goat, cow and pig in faunal assemblages from early neolithic village sites in Greece

Site	% sheep	% goat	% cow	% pig	Total no. ident.*	Reference
Akhilleion	-	86	4	9	2256	Bökönyi, 1989
Argissa	84	0	5	11	2178 (21)	Boessneck, 1962
Ay. Petros	-	85	7	8	-	Schwartz, 1982
Knossos	58	8	16	17	1999 (41)	Jarman and Jarman, 1968
Lerna	-	64	12	24	141	Gejvall, 1969
Nea Nikomedeia	-	71	15	15	439	Higgs, 1962
Otzaki	-	52	31	17	297	Boessneck, 1955
Prodhromos 1-2	48	9	29	14	1362 (155)	Halstead and Jones, 1980
Prodhromos 3	40	10	38	12	285 (21)	Halstead and Jones, 1980
Servia	-	66	17	17	-	Watson, 1979
Sesklo	-	67	13	20	447	Schwartz, 1982

* total number of specimens identified to sheep, goat, sheep/goat, cow and pig
(in parentheses : total number of *postcranial* specimens only identified to sheep or goat)

have existed in the Neolithic and there is no evidence for such transhumant movements in early prehistory (HALSTEAD, 1987b ; CHERRY, 1988). Among lowland, mixed farmers in the recent past, a flock of a few hundred sheep signified considerable wealth and access to the labour of more than one household. A herd of mixed livestock, with different grazing requirements, places even greater demands on herding labour and such problems would have been compounded in a neolithic landscape lacking large and consolidated areas of pasture.

The conclusion seems inescapable that, even with some collaborative herding between domestic groups, individual early neolithic households could not as a rule have maintained demographically viable herds over a single generation. By the later Neolithic, a more balanced mixture of livestock (HALSTEAD, 1981) reduces the implied minimum size of household herds, though a *mixed* herd of even 50-100 livestock might still have severely stretched the labour resources of an individual household.

Instead, it is argued, the diversity of the faunal record reflects frequent inter-household exchange - and not just of joints of meat between households specialising in the raising of one species of domestic animal. If early neolithic households did specialise in this way, cattle (the least common species) would have been kept by only one or two households in each village (if 50-300 inhabitants constituted, say, 10-60 nuclear- or 5-30 extended-family households), so that there would have been very limited opportunities for establishing new cattle herds. Given the inevitable periodic failure of such specialist households, therefore, cattle would have been very vulnerable to extinction, both locally and regionally - a scenario inconsistent with the strikingly constant representation of all four domesticates in the faunal record. Whether or not joints of meat were also exchanged, it seems that individual households must have kept mixed herds of domestic animals and that livestock must have circulated between households. In the absence of evidence for central redistributive institutions, at least in the earlier Neolithic (HALSTEAD, 1989b), it is concluded that livestock circulated through reciprocal exchanges between households.

Whether regular exchanges of livestock only took place between neighbouring households cannot be determined from the very rough calculations possible here, though the suggested minimum populations of domesticates do not self-evidently exceed the herding capabilities of a village of inhabitants. Over 500 years (the approximate duration of the Early Neolithic), however, the minimum populations of domesticates rise to c. 300-400 cattle (to maintain demographic viability) and 6000-8000 smaller stock (to conform with faunal evidence for the relative proportions of the different species). Similarly, to maintain genetic diversity in the long term, a breeding population of several hundred individuals of each species would be needed. For example, a minimum population of c. 200-500 individuals, recommended for captive Père David's deer with a reproductive potential of one fawn/hind/year (FOOSE, 1983 ; FOOSE AND FOOSE, 1983), may be broadly appropriate for cattle, with progressively higher targets for sheep, goat and pig because of their shorter generation time, larger family size and generally less stable demography (cf. FRANKLIN, 1980 : 141). Given the close spacing of many early farming villages (HALSTEAD, 1989b) and the difficulty of detecting neolithic clearance in the palynological record (BOTTEMA, 1982), these populations will surely have exceeded the grazing, browsing and pannage resources of individual villages (cf. HALSTEAD, 1989a). In the long-term, therefore, and in the face of occasional catastrophic losses through disease, predation, extreme weather conditions and starvation, the continued survival of populations of domestic animals must have involved at least occasional longer-distance exchange of livestock between different villages.

The context of exchanges of livestock in neolithic Greece

Reciprocal exchanges between households may be understood in a number of different ways. As has already been argued, exchange of livestock would have integrated a number of herds small enough to be manageable at a household level into breeding populations large enough to be demographically viable. At the same time, such exchanges probably served to forge and maintain social relationships - indeed, in some pastoral societies, loans or gifts of stock are virtually inseparable from kinship. Socially embedded exchanges of livestock may in turn be an effective means for pastoralists to “bank” surplus (DAHL, 1979). The large herds built up as security against losses of stock in bad years are very demanding of labour and vulnerable to disease and poor nutrition, while the loaning or giving of animals reduces herding costs, spreads the risk of loss through disease or starvation, and establishes social obligations which may be useful in the event of major loss.

Livestock may also serve to bank surplus in mixed farming societies (FLANNERY, 1969). In the face of uncertain yields, many farmers attempt to overproduce staple grain crops and to store the resulting "normal surplus" for use in the event of future scarcity (ALLAN, 1965 ; FORBES, 1982). The efficacy of direct storage of grain is limited, however, because grain in long-term storage may spoil before it is used. Spoilage not only eliminates a potentially vital food source, but also represents wastage which may undermine the drive to overproduction. Surplus grain may also be banked indirectly, and recent Greek farmers have used livestock as vehicles of indirect storage in several inter-related ways (FORBES, 1982 ; HALSTEAD, 1990).

(1) Surplus grain (or cash from the sale of surplus grain) may be used to buy "animal capital" - a small herd which may provide the household with milk and meat, but which is also a renewable store of wealth.

(2) Surplus grain may similarly be used to acquire additional labour for herding the "animal capital".

(3) Livestock may be fed spoiled stores of grain and may also be turned onto failed crops, to salvage some benefit from crops not worth harvesting.

(4) Surplus household labour and land may be invested in fodder crops to enhance the productivity of "animal capital".

(5) Surplus food may be fed to livestock, in some cases opportunistically redefining the cultural boundary between food and fodder so that such indirect storage is not readily apparent. For example, in circumstances of plenty the processing of food crops may be cut short, with incompletely threshed or winnowed grain being fed to livestock. Similarly, low-status grains such as barley may be fed to animals in times of plenty, but to humans in the event of shortage.

(6) Finally, livestock may serve as a vehicle for banking surplus grain in a longer-term "savings account", when animal capital is exchanged for land or when animals are slaughtered for the ceremonial occasions (e.g. wedding feasts) and hospitality to guests which cement social alliances and obligations.

Thus surplus grain (and surplus labour and land) may be "banked" in livestock, or converted by livestock into a more exchangeable form, and some farmers explicitly recognise their herd as "animal capital" for use in economic necessity (shortage of food, the marriage of a daughter etc.).

In the event of such necessity, surplus can be recouped from livestock in a number of ways.

(1) The herd may be eaten - a relatively ineffective solution recorded during the severe famine of World War 2.

(2) Livestock may be sold (e.g. to a farmer wishing to build up "animal capital") and the proceeds used to buy grain or meet other necessary expenditure ; in severe crises, long-term "savings" too may be consumed, by selling land or borrowing grain from kinsmen.

(3) Surplus labour may be hired out, for example to a more successful farmer willing to reward a herdsman with grain or cash.

(4) Low-status foods may be reserved for human consumption and, in the last resort, crops and crop residues unambiguously classified as fodder (e.g. bitter vetch, bran, chaff) may be eaten by humans.

Thus livestock are not only a vehicle for indirect storage of unwanted surplus, but also provide a rationale for the sustained overproduction of staple food grains and for the regular production of emergency foods (i.e. foods which are, in normal circumstances, culturally unacceptable).

Neolithic farmers in Greece must have faced the same basic problems of uncertain yields from staple grain crops and an uncertain storage life for the surpluses built up after good harvests (HALSTEAD, 1989b). Even in the absence of money and a market economy, neolithic livestock will have offered broadly similar opportunities for indirect storage of temporary agricultural surpluses and the feeding of grain to livestock has been demonstrated in neolithic Switzerland, where faecal material is preserved by waterlogging (ROBINSON and RASMUSSEN, 1989). Certain aspects of neolithic stock husbandry in Greece are highly compatible with indirect storage.

(1) Although broadly conforming to a "meat" production model (PAYNE, 1973), with high levels of juvenile/sub-adult mortality, young neolithic livestock were culled over a long period of time : sheep and goats from c. 6-12 months (or earlier) to 3-4 years (HALSTEAD, 1987a : 79 fig. 3) and pigs up to c. 2

years of age (VON DEN DRIESCH and ENDERLE, 1976). Perhaps the nutritional plane of livestock was highly variable, with some animals fed surplus grain and so ready for slaughter at an earlier age than others. In addition, animals may have been slaughtered not at some perceived optimal meat weight, but in response to the need for meat to make up for a shortage of staple grains or to celebrate a particular rite of passage.

(2) A striking feature of ovicaprid mortality data is the rarity of adult deaths (HALSTEAD, 1987a : 79 fig. 3). Unless an artefact of some unrecognised taphonomic bias or of a diet which caused minimal tooth wear (cf. HALSTEAD, in press a), this suggests a form of husbandry rather unfamiliar in recent and historical systems of *herd* management. In such systems, breeding females tend to be treated as capital assets, and females of proven productivity tend to be culled only when their lambing/kidding rate or milk yield declines (e.g. PAYNE, 1973 ; KOSTER, 1977). Neolithic management in Greece seems to have drawn a less clear distinction between capital assets and productive output, maintaining a fast turnover of breeding females. The implication is that neolithic farmers were not concerned to maximise the productivity of breeding females, but were opportunistically raising, fattening and slaughtering livestock in response to a variable supply of fodder and/or variable demand for meat (cf. SHERRATT, 1982 : 25 on the "family pig"). It might also be noted that reliance on young adults for breeding will have reduced the likelihood of inbreeding depression (by restricting "family size" - cf. FRANKLIN, 1980), but will have increased the size of herd necessary for demographic viability (by exaggerating the proportion of young, non-breeding females).

(3) A mixed herd of sheep, goats, pigs and cattle will have had obvious advantages for indirect storage, in broadening the range of food sources which could be used by the herd and in reducing the risk of losing the entire herd through disease. In the Early Neolithic the commonest domesticate was the sheep, which is particularly suitable for indirect storage by virtue of its ability to lay down the fat deposits (REDDING, 1981) critical to human use of meat as an energy source (SPETH and SPIELMANN, 1983). During the later Neolithic, the relative importance of sheep in the faunal record declined in favour of goats, pigs and cattle, but this may not indicate reduced absolute numbers of sheep as widespread destabilisation of the landscape (VAN ANDEL *et al.*, 1990) may reflect a radical increase in the scale of herding activity.

(4) Cattle, by virtue of their relatively slow rate of reproduction and relative scarcity in the faunal record, were probably the domesticate most vulnerable to local extinction. In addition, their large body size makes them far less amenable to consumption on a domestic scale than sheep, goats and pigs and there is no evidence as yet that neolithic cattle fulfilled any specialised role, such as traction, for which the smaller domesticates were not suited (e.g. HALSTEAD, 1987a : 81 tab. 2 ; SHERRATT, 1981). In the future, closer attention to contextual associations may clarify whether or not cattle were eaten in more "public" or ceremonial circumstances than the other domesticates. Cattle may also have been valued and exchanged, however, because their large size and slow demographic turnover makes them a more reliable "bank" than the smaller domesticates. African pastoralists use the more rapidly reproducing sheep and goats to build up a herd and then exchange these small stock for larger and less vulnerable cattle and camels (DAHL and HJORT, 1976). Perhaps cattle similarly served as a form of long-term indirect storage for neolithic farmers in Greece : surplus grain could have been fed to or exchanged for small stock and the latter could subsequently have been exchanged for cattle, much as "animal capital" has been exchanged for land among recent Greek farmers.

Whatever the overt rationale for the stock management decisions of neolithic farmers, therefore, it is highly likely that livestock were fed surplus grain and were regularly exchanged between households and so did, in effect, serve as vehicles for indirect storage.

Conclusion : from reciprocity to redistribution

The sceptical reader may feel that a rather ambitious edifice has been built on weak foundations. First, the fundamental argument that stock husbandry was organised at a domestic level might be rejected, although this interpretation of Greek neolithic architecture is strengthened by cross-cultural analysis of residential behaviour by FLANNERY (1972), FLETCHER (1981) and WHITELAW (1983a). Secondly, the evidence that individual neolithic households consistently kept (or rather consumed) all four species of livestock is very limited, highlighting one priority area for future excavation and faunal analysis. Thirdly, the conclusion that household herds of mixed livestock would not have been viable rests on assumptions, which may be questioned, concerning the demography of livestock, availability of labour for herding and nature of neolithic pasture resources. Arguably these assumptions have erred on the side of caution and any errors do not alter the conclusion drawn.

The conclusion that livestock was regularly exchanged between households has been drawn with particular reference to neolithic Greece, because several elements in the argument (architectural segregation of the family household, household subsistence diversification, uneven representation of the four livestock species, a more or less wooded environment) are not valid for all parts of Europe and the Near East. Nonetheless, an argument on similar lines could probably be developed for many parts of the Old World (e.g. SHERRATT, 1982 ; BOGUCKI, 1988). The argument that domestic animals served to "bank" agricultural surplus is of widespread relevance to any discussion both of the significance of livestock in early farming economies and of the risk-buffering and social behaviour of early farmers. It may also shed light on one striking characteristic of the redistributive economies of the late bronze age palaces of southern Greece.

Sheep and wool played a particularly prominent role in palatial redistribution. The palace of Knossos on Crete, for example, controlled over 100,000 sheep, mostly wethers producing wool for distribution to palatial textile-workers making fine cloth (KILLEN, 1964, 1984). The ultimate destination of the finished textiles is rarely recorded in the archives, but more durable products of palatial workshops (e.g. metal and glass-paste jewelry) circulated widely beyond the palaces. These fine craft goods may have been used to extract agricultural surplus from the surrounding territory, because palace storerooms contain charred remains of several cereal and pulse crops which are not attested in the archives and so apparently were neither produced by the palaces nor acquired through taxation (HALSTEAD, in press b).

Clearly the palaces were undermining household risk-buffering potential, by extracting domestic agricultural surplus and by maintaining vast flocks of sheep which will have reduced the availability of pasture for non-palatial livestock (CHANG and KOSTER, 1986). The palaces must have provided subsistence relief for their subjects, therefore, as in the Biblical story of Joseph's provision for seven years of famine - if only to preserve their own resource base. Culled wool sheep, far too numerous to be consumed by the palatial elite, may have been one mobile element in such relief measures and it may be significant in this respect that sheep are particularly effective in storing fat.

Thus the central concern of the palaces with sheep and wool may well have been an elaboration of the simpler system of banking in livestock suggested for neolithic Greece. Indeed, the transition from household-level reciprocity to centralised redistribution of livestock may partly be understood in terms of the potential for unequal accumulation of resources inherent in such banking systems (HALSTEAD and O' SHEA, 1982). In short, inevitable long-term inequalities in inter-household exchanges of staple grains may have been matched and sustained by complementary flows of other household resources such as labour and livestock. The result was a highly stratified society, controlled by an elite with privileged access to regional resources of crops, livestock and human labour, but with a residual responsibility for regional-scale subsistence relief.

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