Chapter 22: Animal Remains: Discussion

by

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§ 22.1 Introduction

This chapter presents the full report on the animal re-mains from the Neolithic to Bronze Age settlement at Kissonerga. The contribution on the animal remains in § 10 is a partial synopsis of this full report, and presents no additional information or interpretation. For the convenience of the reader of this full report, all tables and figures which have been included in § 10 have been duplicated in the present chapter.

The excavations at Kissonerga have yielded a larger number of identifiable faunal remains than any other archaeological site, of whatever period, in Cyprus. A total of 11,302 fragments of mammalian bone (excluding mice and shrews) has been identified (Table 22.1), of which fallow deer (*Dama mesopotamica*), pig and caprines together account for 10,988 fragments, or 97.2%. Fox remains are reasonably common, and cattle, dog, cat, an equid and the Cypriot pigmy hippo-potamus (*Phanourios minutus*) are represented by lesser quantities of material. In addition to these terrestrial mammals, single teeth of a cetacean (whale) and a seal could not be more closely identified. Moderate quantities of bird remains (107 fragments), many of which proved identifiable, were also recovered and will be discussed below. Fish, mollusc and crab remains were not uncommon at Kissonerga, and this material is discussed in § 13 and 14. A total of 323 kg of non-fossil, terrestrial mammalian bone was recovered of which 51.8% by weight proved identifiable (Table 22.2).

Identification was attempted for almost all fragments of the larger animals (viz. cattle, deer, pig and caprines), but excluded vertebrae other than the atlas, axis and sacrum, as well as ribs. Teeth of the larger animals which comprised less than half of a complete tooth crown were also excluded. For the much less abundant smaller creatures any identifiable fragment was counted.

Thousands of measurements were taken on the Kissonerga animal bones, but metrical data are only presented here insofar as they serve to illustrate points made in the text. Most measurements were taken following the guidelines of von den Driesch (1976), and where this was not the case this is indicated. In the scatter diagrams displaying metrical data, symbols located on the axes represent items for which only the one dimension represented on that axis could be recorded. In such cases it is generally quite apparent approximately where in the plotted scatter of points the symbol would have occurred had both dimensions been recordable.

In keeping with the general aims of this primary publication of the results of excavations at Kissonerga, the present report on the animal remains is intended mainly as a presentation of information, and it is focused at the intra-site level. Basic interpretations of various aspects of the data have been presented here, but clearly such a large body of faunal data merits

Table 22.1. Total numbers of identified mammalian bone fragments

Taxon	Total	%
Deer	4,375	38.7
Pig	4,615	40.8
Caprine	1,998	17.7
Fox	210	1.9
Bos	51	0.5
Dog	33	0.3
Cat	16	0.1
Hippopotamus	1	-
Equid	1	-
Cetacean	1	-
Seal	1	-
Total	11,302	100.0

Table 22.2. Weights of non-fossil terrestrial mammalian bone

Taxon	Weight (g)	%
Identified		
Deer	84,016 [1]	50.2
Pig	52,597	31.4
Caprines	28,340 [2]	16.9
Bos	1,692	1.0
Fox	460	0.3
Dog	120	0.1
Equus	50	+
Cat	40	+
Total Identified	167,315 (51.8% of total sample)	
Unidentified [3]	155,717 (48.2% of total sample)	
Total Sample	323,032	

[1] figure includes 11,070 g of antler
[2] figure includes 4,903 g of horncore
[3] 0.4% of unidentified material clearly derives from large animals of Bos/Equus size, whilst these large animals account for 1.0% of the weight of identified material.

further discussion in the context of what is known from other Early Prehistoric sites on the island of Cyprus, and, more generally, in the context of a wider ge o-graphical and temporal framework. Such a discussion does not, however, fall within the scope of this contr i-bution, and it must be reserved for another occasion. For a recent attempt at a more synthetic faunal-based view of economic developments in Early Prehistoric Cyprus the reader is referred to Croft (1991).

§ 22.2 Sample bias and recovery

§ 22.2.1 Sample bias

The extent to which all of the animals which contri b-uted to a faunal sample are actually represented in it, is dependent upon a range of cultural and environmental factors. Normally the bone sample recovered from an ancient settlement site is but a small fraction of the total amount of skeletal material from which it derives, and this is, in turn, often only a tiny portion of the r e-mains of the animal populations which were exploited by the human inhabitants of the site. Nevertheless, the fullest possible understanding of human exploitation of animal populations would require that these "target" populations of animals be reconstructed. However, since the adequacy of archaeological samples to serve as a basis for extrapolation to target populations cannot be evaluated without prior knowledge of the structure of the very target populations which are to be reco n-structed, zooarchaeology may be seen to be working within severe constraints.

Taphonomic processes regulate the transition from the complete skeletons of slaughtered animals to the usually much-diminished assemblage of animal bone which awaits the excavator. Since an understanding of these processes is crucial if reconstructions of the past based on faunal data are ever to attain a high degree of reliability, considerable attention has been paid to them for well over a decade (e.g. Behrensmeyer and Hill 1980; Binford 1981). Notwithstanding that progress has been slow and that no easy answers have emerged, an essentially new climate of thought has emerged in zooarchaeology. Perhaps the most important effect of this has been to focus attention on the fact that a r-chaeological faunal assemblages are normally severely attenuated and consequently furnish a biased set of data from which to reconstruct the past.

Although adequate strategies for circumventing the distorting effects of the differential destruction of the bones of different taxa and of different elements within a given taxon, have yet to be devised, it is possible to make a rough estimate of the probable overall extent of assemblage attenuation. Despite the fact that MNI (Minimum Number of Individuals) figures are known to possess severe deficiencies as a basic unit of faunal quantification, they may usefully be employed in ma k-ing such an estimate. It is, furthermore, necessary to assume that the dry weight of the skeleton amounts to a constant proportion of total live bodyweight for each of the main animals under discussion viz. deer, pig and caprines. Following Bourdillon and Coy (1980, 83) it has been assumed that this proportion is 7%.

If (minimal) MNI figures (generated by Grayson's (1973) "minimum distinction" approach) for each of the main taxa represented at Kissonerga are multiplied by 7% of the estimated live bodyweight of a single i n-dividual, the resulting value represents a minimal est i-mate of the weight of bone which that taxon ought to have contributed to the assemblage. The estimates of live body weight employed are deer 96 kg, pig 60 kg and caprines 34 kg. (The use of these figures has been discussed elsewhere by the writer (Croft 1988a; 1991, Table 1), although the weight estimate used here for pig is reduced in order to take account of the high fr e-quency of pre-adult culling at Kissonerga.) The diffe r-ences between the sum of the estimates of potential bone weight for all taxa and the weight of bone actually recovered suggests the *minimum* amount of bone which has been lost between the slaughter of the animals and the recovery of the faunal sample.

The calculation for the Kissonerga animal bone assemblage is as follows: MNI figures of 136 deer, 97 pigs and 67 caprines suggest a theoretical minimum assemblage total of 1,480.7 kg. The actual total weight of animal bone recovered (excluding identified remains of taxa other than these main three, but including un i-dentified material of the correct general size) was 320.1 kg. Thus, a *minimal* estimate of the proportion of the Kissonerga assemblage which is missing is 78.4%.

Any claim for the accuracy of the forgoing calcul a-tions would almost certainly be misplaced; the result is best viewed as an extremely rough estimate. An est i-mated level of attrition of around four-fifths does, ho w-ever, serve to illustrate the point that Kissonerga is no exception to the general rule that faunal samples no r-mally represent a very small proportion of even the minimum amount of material from which they could possibly have been derived.

Table 22.3. The impact of wet sieving on the bone a s-semblages for selected animals

Taxon	*Number of identifiable fragments*		*Theoretical total assemblage size*	*Estimated % missed*
	Excavated	*wet sieved*		
Cattle	51	0	51	0
Deer	4,313	62	10,513	58
Caprine	1,964	34	5,398	63
Pig	4,505	110	15,505	70
Fox	193	17	1,893	89
Bird	75	32	3,275	97

Table 22.4a-d. Breakdown by element of identified material of the main animal taxa

Table 22.4a. Deer

Element	Left	Right	ND	Total
scapula	85	90	17	192
p. humerus	45	42	4	91
d. humerus	128	135	8	271
p. ulna	71	82	-	153
d. ulna	4	4	-	8
p. radius	100	113	2	215
d. radius	73	94	2	169
p. femur	46	64	28	138
d. femur	90	132	4	226
patella	29	24	1	54
p. tibia	55	57	-	112
d. tibia	92	111	1	204
astragalus	47	48	4	99
calcaneum	52	46	2	100
nav-cuboid	16	16	-	32
p.m/carpal	34	21	-	55
d.m/carpal	8	7	45	60
p.m/tarsal	27	23	-	50
d.m/tarsal	75	12	38	67
p.m/podial	-	-	4	4
d.m/podial	-	-	27	27
atlas	-	-	-	25
axis	-	-	-	57
pelvic frags	-	-	-	331
sacrum	-	-	-	45
sesamoid	-	-	-	3
carpals	-	-	-	42
tarsals	-	-	-	13
os malleolare	-	-	-	12
longbone shafts	-	-	-	429
phalanx 1	-	-	-	226
phalanx 2	-	-	-	145
phalanx 3	-	-	-	94
Total				3,749
number of whole bones possessing two articular ends, to be subtracted				4
TOTAL POSTCRANIAL FRAGMENTS				3,745
head				346
antler				284
TOTAL FRAGMENTS				4,375

Table 22.4b. Pig

Element	Left	Right	ND	Total
scapula	76	84	2	162
p. humerus	43	47	-	90
d. humerus	94	96	3	193
p. ulna	78	70	-	148
d. ulna	16	12	-	28
p. radius	63	64	1	128
d. radius	34	40	-	74
p. femur	34	50	1	85
d. femur	72	76	-	148
patella	12	11	-	23
p. tibia	51	45	1	97
d. tibia	41	44	-	85
astragalus	44	29	1	74
calcaneum	79	67	1	147
atlas	-	-	-	66
axis	-	-	-	21
sacrum	-	-	-	24
pelvic frags	-	-	-	260
carpals	-	-	-	26
tarsals	-	-	-	39
longbone shafts	-	-	-	183
m/carpal III/IV	-	-	-	100.5
m/tarsal III/IV	-	-	-	57
m/podial III/IV	-	-	-	77
phalanx 1	-	-	-	308
phalanx 2	-	-	-	107
phalanx 3	-	-	-	124
*Total**				2,874.5*
number of whole bones possessing two articular ends, to be subtracted				9
TOTAL POSTCRANIAL FRAGMENTS				2,865.5
head				1,004
TOTAL FRAGMENTS				3,869.5

* In order that this total should be comparable with those for the other taxa it excludes 325 fragments of metapodia II and V, 125 accessory phalanges and 60 fragments of fibula, since these elements have no analogues in the deer or caprine skeleton. Furthermore, only half of the full total of 469 fragments of metapodia III and IV is included, since the anatomical analogue of these paired elements is a single cannon bone.

§ 22.2.2 Recovery

During the first three seasons of work at Kissonerga dry sieving was conducted sporadically, at the discretion of individual archaeologists, using a variety of sieves and primarily with a view to recovering small artefacts. This unsatisfactory situation was remedied in the fourth (1986) season with the introduction of a more syste m-atic programme of flotation and water sieving emplo y-ing a standard range of meshes (1 mm for the wet sieve) and geared primarily to the recovery of biological remains.

Whilst the most conspicuous result of this sampli ng programme has perhaps been the recovery of a su bstan-tial assemblage of plant remains by flotation (§ 11), the consequences for the faunal assemblage of wet sieving have been not inconsiderable. The fact that smaller items tend to be more prevalent amongst the finds when excavated deposits have been sieved than when they have not is reflected in the fact that the wet sieve yielded a greater proportion of the identified remains of the smaller rather than the larger animals. Thus, no cattle remains and only 1.4% of deer remains were r e-covered in this way, but 8.1% of fox remains and 29.9% of bird remains, to give but a few examples, were recovered in the wet sieve.

If, for the sake of argument, it is assumed that 1% of excavated deposits was wet sieved (certainly an ove r-estimate), then the figures quoted above may be put into some sort of perspective. Of a total of 4,375 identified deer bones from Kissonerga, 4,313 were recovered during excavation and a further 62 from wet sieving an estimated 1% of all excavated deposits. This suggests that wet sieving of 100% of the excavated deposits

Table 22.4c. Caprines

Element	Left	Right	ND	Total	Includes Goat	Sheep
scapula	40	34	3	77	29	5
p. humerus	23	15	-	38	3	1
d. humerus	53	67	2	122	13	1
p. ulna	52	47	-	99	21	2
d. ulna	3	4	-	7	-	-
p. radius	44	36	-	80	42	4
d. radius	27	31	-	58	26	-
p. femur	32	26	1	59	21	7
d. femur	36	36	1	73	-	-
patella	5	8	1	14	-	-
p. tibia	27	25	-	52	-	-
d. tibia	40	38	-	78	4	-
astragalus	27	29	1	57	32	2
calcaneum	27	33	5	65	30	5
nav-cuboid	9	9	-	18	8	-
p.m/carpal	13	24	-	37	2	1
d.m/carpal	2	7	11	20	8	1
p.m/tarsal	25	22	5	52	3	-
d.m/tarsal	5	4	9	18	7	1
p.m/podial	-	-	3	3	-	-
d.m/podial	-	1	35	36	8	-
atlas	-	-	-	37	3	3
axis	-	-	-	48	5	1
pelvic frags	-	-	-	156	19	2
sacrum	-	-	-	17	-	-
sesamoid	-	-	-	1	-	-
os malleolare	-	-	-	5	-	-
carpals	-	-	-	9	-	-
tarsals	-	-	-	3	-	-
longbone shafts	-	-	-	106	1	1
phalanx 1	-	-	-	115	1	-
phalanx 2	-	-	-	73	8	-
phalanx 3	-	-	-	39	22	5
Total				1672	316	42
number of whole bones possessing two articular ends and fused proximal ulnae/radii, to be subtracted				10		
TOTAL POSTCRANIAL FRAGMENTS				1662	316	42
head				257	4	-
horncore				79	42	2
TOTAL FRAGMENTS				1998	362	44

Table 22.4d. Fox

Element	Left	Right	ND	Total
scapula	2	3	-	5
p. humerus	-	3	-	3
d. humerus	8	5	-	13
p. ulna	8	13	-	21
p. radius	2	4	-	6
d. radius	1	4	-	5
p. femur	3	2	1	6
d. femur	5	2	-	7
p. tibia	-	3	-	3
d. tibia	6	6	-	12
astragalus	1	1	-	2
calcaneum	3	2	-	5
metacarpal	7	7	-	14
metatarsal	8	8	-	16
metapodial	-	-	11	11
vertebra	-	-	-	6
atlas	-	-	-	2
pelvic frags	-	-	-	12
sacrum	-	-	-	1
longbone shafts	-	-	-	18
phalanges	-	-	-	14
head	-	-	-	33
Total				215
number of whole bones possessing two articular ends, to be subtracted				5
TOTAL FRAGMENTS				210

tial recovery rates and a failure to retrieve more than a fraction of the total number of bone fragments on a site poses severe problems for the accurate interpretation of the faunal assemblage which was recovered. In at-tempting to evaluate what the assemblage contains, it is clearly necessary to consider what it does not contain. This state of affairs is by no means peculiar to the Kis-sonerga assemblage, and will inevitably prevail to some degree in any assemblage which was retrieved by less than total sieving through a fine wet sieve. The imple-mentation of the sampling programme at Kissonerga has at least permitted some estimate to be made of the severity of the problem of partial recovery, and the re-sults, although perhaps disquieting, provide a general indication of the extent to which caution must be ap-plied in accepting the credibility of the conclusions which have been drawn.

Although the conclusions of faunal analyses such as the present one are conventionally (if implicitly) pre-sented as truths, the foregoing *caveat* reminds us that such "truths" are, in fact, merely approximations with a margin of error of virtually indefinable extent. However sound the scientific background and however developed the zoological and statistical expertise of the practi-tioner, zooarchaeological interpretation remains a frus-tratingly approximate art.

should have yielded 6,200 identifiable deer remains, i.e. considerably more than were actually recovered on site. Adding together the number of identifiable deer re-mains which were retrieved and the theoretical number which were overlooked it may be concluded that some 58% of available identifiable deer bones was missed. For other taxa the equivalent figures are caprines 63%, pig 70%, fox 89% and bird 97% (Table 22.3). Thus, by comparison with the recovery rate for deer remains (which was itself less than ideal), the recovery rate for the remains of the smaller caprines and pig was rather poor, whilst that for fox and bird (very small creatures) was comparatively very poor, the vast majority of their remains having apparently been overlooked.
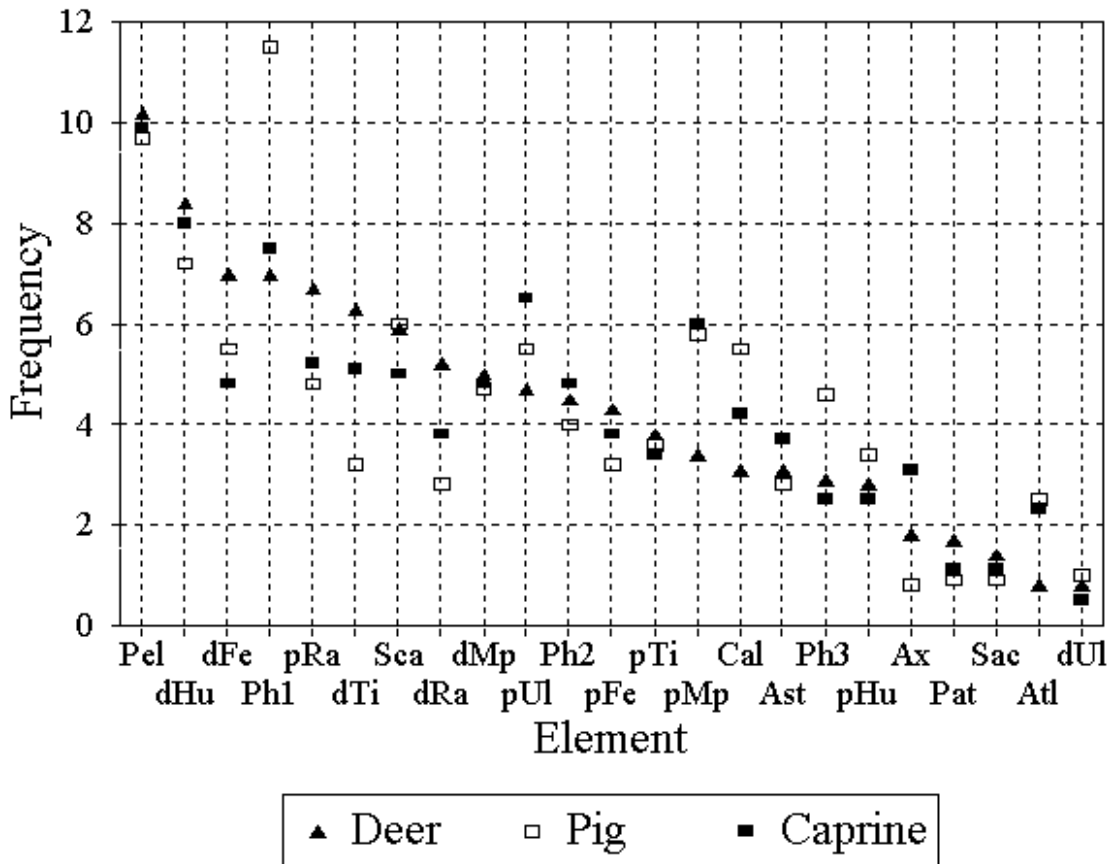
The situation which has been described of differen-

* Frequencies are expressed as a percentage of the total number of identified fragments of those postcranial elements which are represented. Pig fib u-lae, metapodia ii and v and accessory phalanges have been disregarded, and counts of metapodia iii and iv have been halved (see § 22.5)

Abbreviations: p=proximal, d=distal, Pel=pelvis, Hu=humerus, Fe=femur, Ph1=phalanx 1, Ph2=phalanx 2, Ph3=phalanx 3, Ra=radius, Ti=tibia, Sca=scapula, Mp=metapodial, Ul=ulna, Cal=calcaneum, Ast=astragalus, Ax=axis, Pat=patella, Sac=sacrum, Atl=atlas

Fig. 108: Element frequency for deer, pig and caprines

§ 22.3 Skeletal element representation

A breakdown by element of the remains of the more abundantly represented animal taxa at Kissonerga is presented in Table 22.4a-d. It is very commonly the case in faunal assemblages that cranial fragments of pig are considerably more abundant relative to postcranial fragments than those of the ruminants, and this is so here (even if ruminant antler and horncore fragments, which have no counterparts in the pig, are included). Thus, cranial fragments account for 25.6% of identified pig remains, but only 14.4% of deer remains and 16.8% of caprine remains (calculated on the basis of figures presented in Table 22.4a-c).

Comparison of element frequency amongst the pos t-cranial material for the three main taxa, viz. deer, pig and caprine (Fig. 108), provides little evidence for taxon specific disposal patterns. The most notable di s-parity is perhaps the somewhat greater overall fr e-quency of (non-accessory) pig phalanges (especially of first phalanges) than for the other animals. This could

conceivably reflect a situation in which the feet of the other animals were somewhat less frequently brought onto the site, being more often disposed of elsewhere. This would accord with the idea that deer and at least some caprines were hunted and partially butchered away from the settlement, whilst the pig bones were those of domestic stock, or at least include compar a-tively few remains of feral, hunted individuals. These possibilities are further touched on below, but the el e-ment frequency distributions can hardly be seen as pr o-viding more than the most minimal support for their veracity.

§ 22.4 The animals

§ 22.4.1 Fallow deer (*Dama mesopotamica*)

Despite suggestions that the fallow deer of Early Pr e-historic Cyprus were, in some sense, domesticated (e.g. Davis 1994, 311; Jarman 1976, 42-43; 1982, 66; Zeuner 1958, 133), it is the opinion of the present writer that they were free-living, hunted creatures. The

arguments for the free-living rather than domestic status of the fallow deer have been rehearsed elsewhere (Croft 1988a; 1991, 64-66) and will not be reiterated here. It is stressed, however, that the non-domestic status of the deer should not be taken to imply that their exploitation was a random, unstructured affair. Indeed, culling patterns deduced from deer remains from Ki s-sonerga and other Cypriot sites show very clearly that a

system of game management must have existed amongst the human communities whose subsistence depended heavily upon deer over several millennia.

Epiphysial fusion data for the entire assemblage of Kissonerga deer remains and for 4 chronologically di s-tinct subsamples, are presented in Tables 22.5a and b. The data have been grouped in such a way as to define four broad age stages.

Considering the whole assemblage (Table 22.5a), few deer (8%) seem to have been culled as infants, that is during the first year or so of life. Roughly a quarter (24%) were culled during the juvenile stage, i.e. b e-tween a year and 2-2.5 years of age and a further 12% had died by the end of the subadult stage. Thus, just over a half (56%) of all deer lived on into adulthood, that is beyond 3-3.5 years of age.

Comparison of the deer subsamples for Periods 3 (undifferentiated) and 4 (Table 22.5b) suggests that the culling pattern may have changed somewhat through time at Kissonerga, with increased emphasis on the culling of juveniles and a decrease in the culling of subadult deer. The subsamples for Periods 3A and 3B are too small to be reliable, but suggest that this change may have occurred gradually. Such a change may well reflect an increased concern with productive efficiency in the hunting sector of the animal economy, since the rate of weight gain of young fallow deer slows down significantly after the juvenile stage (Croft 1988a, Fig. 2.5).

Dental fragments of fallow deer which may usefully be aged are insufficiently numerous to permit them to be considered on a period by period basis. A total of 89 items could be examined in the light of the ageing data

Table 22.5a. Mortality of deer, based on epiphysial fusion and taking the assemblage as a whole

Stage	Element	Number fused	Number unfused	% dead by end of stage
Infant	dist. scapula	85	27	
	dist. humerus	241	15	
	prox. radius	209	5	
TOTAL		535	47	8
Juvenile	dist. tibia	169	35	
	dist. m/podial	74	77	
TOTAL		243	112	32
Subadult	prox. humerus	51	37	
	prox. ulna	51	55	
	dist. ulna	5	3	
	dist. radius	94	74	
	prox. femur	86	48	
	dist. femur	97	104	
	prox. tibia	72	40	
	calcaneum	47	27	
TOTAL		503	388	44
Adult				100

Table 22.5b. Mortality of deer in Periods 3A, 3B and 4, based on epiphysial fusion

Stage	Element	Period 3A			Period 3B			Period 3			Period 4		
		F	UF	%	F	UF	%	F	UF	%	F	UF	%
Infant	dist. scapula	10	0		5	4		17	5		48	17	
	dist. humerus	12	1		23	0		40	1		155	13	
	prox. radius	11	0		24	1		40	1		120	3	
TOTAL		33	1	3	52	5	9	97	7	7	323	33	9
Juvenile	dist. tibia	11	2		14	3		31	7		88	19	
	dist. m/podial	15	1		3	5		20	7		28	46	
TOTAL		26	3	10	17	8	32	51	14	22	116	65	36
Subadult	prox. humerus	4	1		7	3		11	4		32	29	
	prox. ulna	3	4		1	3		5	10		35	36	
	dist. ulna	0	0		2	0		2	0		2	3	
	dist. radius	5	7		9	11		14	19		65	47	
	prox. femur	4	2		9	3		15	6		58	38	
	dist. femur	5	7		17	10		24	20		56	60	
	prox. tibia	7	3		15	7		25	10		33	27	
	calcaneum	6	1		5	2		12	3		24	13	
TOTAL		34	25	42	65	39	37	108	72	40	305	253	45
Adult				100			100			100			100
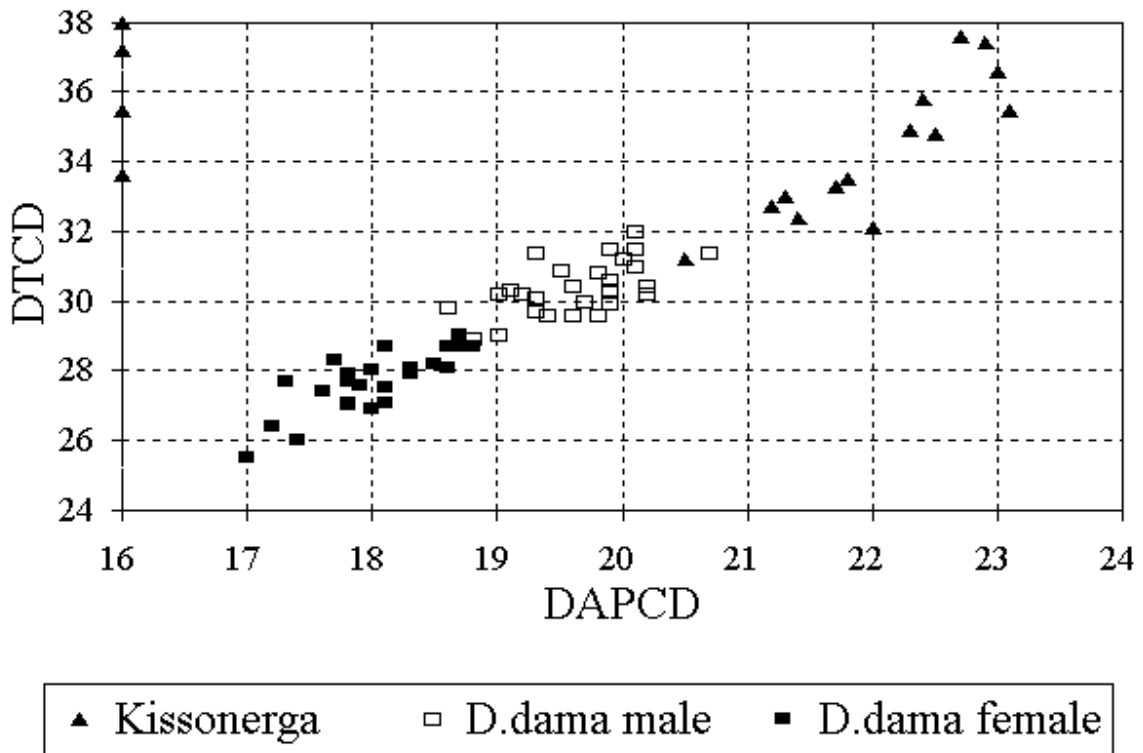
* Dorsovolar diameter (DAPCD) and the maximum lateromedial diameter of the distal articulation (DTCD)
are taken after Ducos (1968, 176 and Fig. 27)

Fig. 109: Deer distal metatarsal. Depth (DAPCD*) x breadth (DTCD*)

of Chapman and Chapman (1975), and the results co n-cur well with the conclusions on deer mortality inferred from epiphysial fusion data. Dental data tend, co m-paratively, to underestimate the incidence of young death, suggesting that only 5% died at ages of 14 months or less (compared with the fusion-based est i-mate of 9% by *c.* 12 months). However, estimates that by 18 months (mid-juvenile stage) 22% had died and that by 22 months (late juvenile stage) 35% had died, accord extremely closely with the fusion evidence.

Tentative estimates of the age of dental fragments older than three years suggest that death occurred most frequently in the 5th year (8 items), but not infrequently in the 4th year (n=3), 6th year (n=4) and 7th year (n=3). Only one item seemed likely to derive from a deer older than 7 years.

Fallow deer exhibit a considerable degree of sexual size dimorphism which is reflected in many of the measurements recorded for the Kissonerga bone sa m-ple. This is illustrated in Fig. 109, a plot of the dors o-volar depth of the distal articulation (DAPCD) of the metatarsal against lateromedial breadth (DTCD) for a sexed sample of modern southern English fallow deer (*Dama dama*) and also for *D. mesopotamica* from Ki s-sonerga. Only fused bones are represented in the scatter
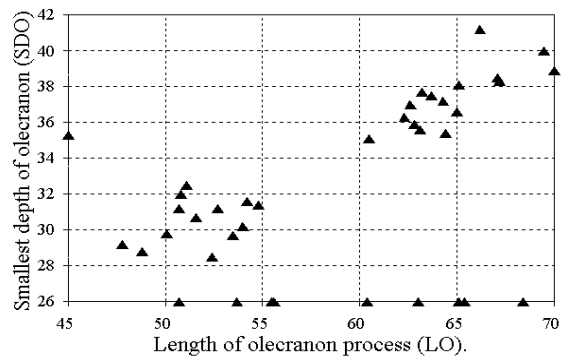
Fig. 110: Deer proximal ulna.
Olecranon length (LO) x depth (SDO)

diagram, and interpretation of the Kissonerga distal metatarsi suggests that those deer which survived b e-yond *c.* 18 months of age included males and females in roughly equal proportions. A plot for fused proximal ulnae (Fig. 110 length of olecranon process against its smallest depth) shows even clearer separation of the sexes and suggests that even as late as the beginning of adulthood (3-3.5 years of age) the sexes still survived in roughly equal proportions.
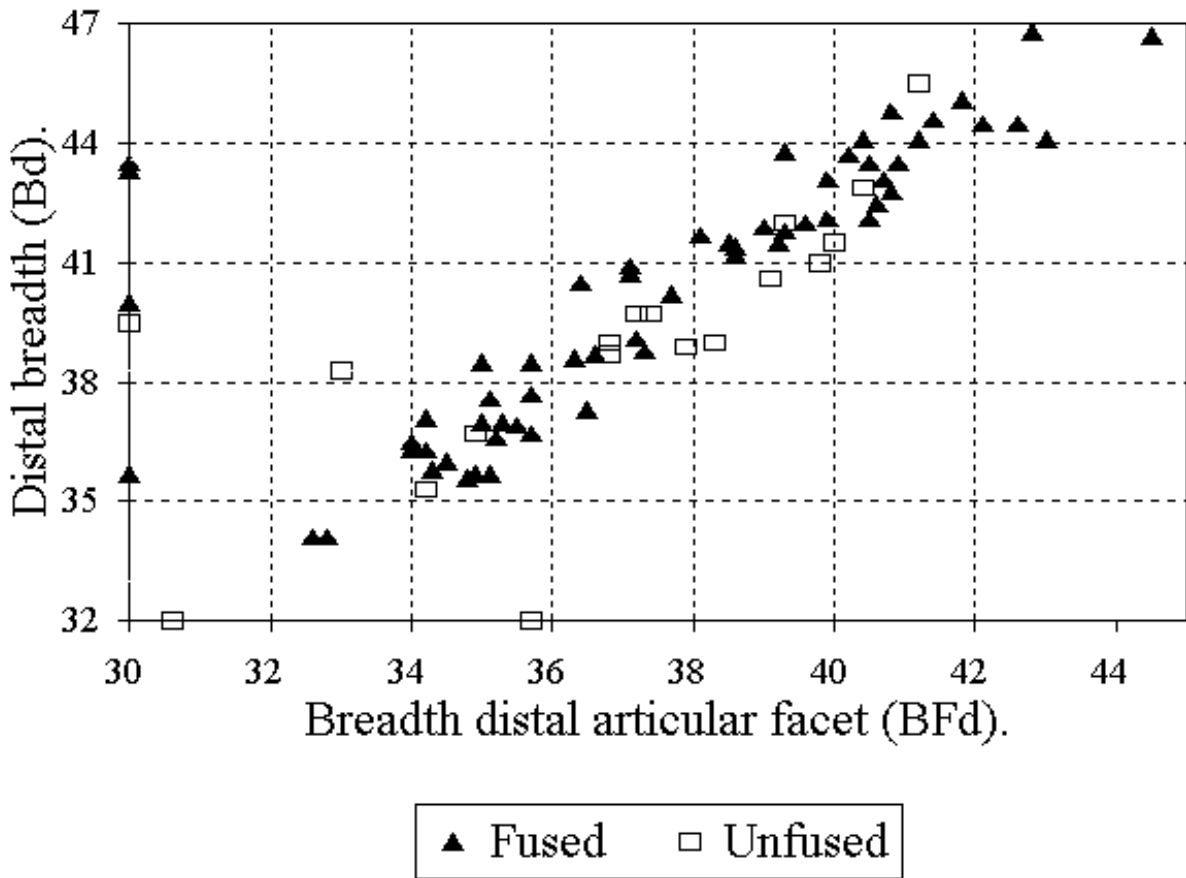
Fig. 111: Deer distal radius. Breadth (Bd) x articular breadth (BFd)

Survival of equal numbers of males and females into adulthood is confirmed by the distal radius, which probably fuses slightly later than the proximal ulna. A plot of the breadth of the distal end (Bd) against the breadth of the distal articular facet (BFd), presented in Fig. 111, includes both fused and unfused specimens. The distribution of points representing mature spec i-mens (solid triangles) consists of two clusters which display reasonably clear separation. These clusters i n-clude similar numbers of points and must represent males (larger) and females (smaller). The majority (two-thirds of eighteen) of unfused specimens (open rectangles) represented in Fig. 111 fall within the size range for mature females. These could include imm a-ture males, but the size distribution of unfused spec i-mens might also suggest that late pre-adult culling co n-centrated on females, whilst very young culling of deer (to the limited extent that this is known to have o c-curred) focused on males whose very immature bones mostly failed to survive.

Assuming that the order of epiphysial fusion of fa l-low deer follows the standard ruminant pattern, then the proximal femur ought to fuse somewhat after the proximal ulna and distal radius. A plot of proximal breadth (Bp) against the depth of the head of the femur

Fig. 112: Deer proximal femur. Breadth (Bp) x depth of caput (DC)

302
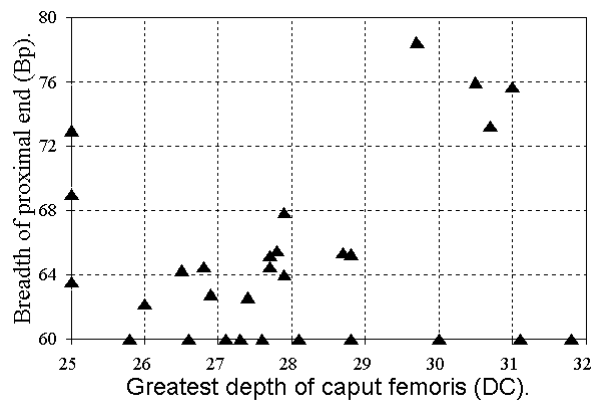
(DC), presented in Fig. 112, also shows clear separation of the sexes and suggests that in the interval between the fusion of the proximal ulna and distal radius and that of the proximal femur there was a concentration on the culling of bucks, since those deer which survived beyond the age at which the proximal femur fuses appear to comprise almost three-quarters does.

Table 22.6a. Mortality of pigs, based on epiphysial fusion and taking the assemblage as a whole

Stage	Element	Number fused	Number unfused	% dead by end of stage
Infant	dist. scapula	63	47	
	dist. humerus	101	92	
	prox. radius	98	31	
TOTAL		262	170	39
Juvenile	dist. tibia	50	46	
	dist. fibula	11	15	
	calcaneum	26	86	
	dist. m/podial	219	283	
TOTAL		306	430	58
Subadult	prox. humerus	17	73	
	prox. ulna	14	83	
	dist. ulna	4	24	
	dist. radius	14	59	
	prox. femur	18	65	
	dist. femur	16	134	
	prox. tibia	20	78	
TOTAL		103	516	83
Adult				100

Thus, it would seem that almost half of all fallow deer died before reaching adulthood, that is before attaining 3-3.5 years of age, and that these included similar numbers of males and females. Shortly after this age, however, the Kissonerga hunters concentrated on the culling of young bucks, since amongst those deer which lived into adulthood (as defined by the fusion of the proximal femur), does apparently outnumbered bucks by almost 3:1.

The incidence of death prior to about 3 years of age finds broad confirmation, for the males at least, in the nature of the sample of unshed antlers from Kissoneerga. Of a total of 21 unshed antler bases recovered, 6 clearly lack any development of a brow tine and therefore represent individuals which died in their second year, whilst a further two were judged to be second-head antlers, representing bucks culled in their third year.

§ 22.4.2 Pig

Epiphysial fusion data for the entire Kissonerga assemblage of pig bones, and for 4 chronologically distinct subsamples, are presented in Tables 22.6a and b.

Epiphysial fusion data for pig bones for the site as a whole indicate (Table 22.6a) that 39% died during the infant stage at less than about a year of age. A further 19% died as juveniles, at *c*. 1 to 2-2.5 years old, 25% died during the succeeding year as subadults, leaving 17% to be slaughtered as adults at ages greater than 3-3.5 years.

The nature of the pig subsamples for Periods 3 (undifferentiated) and 4 (Table 22.6b) suggest that, whilst

Table 22.6b. Mortality of pigs in Periods 3A, 3B and 4, based on epiphysial fusion

Stage	Element	Period 3A			Period 3B			Period 3			Period 4		
		F	UF	%	F	UF	%	F	UF	%	F	UF	%
Infant	dist. scapula	4	0		5	4		11	5		39	34	
	dist. humerus	0	2		7	7		10	13		74	61	
	prox. radius	3	0		8	4		12	4		66	20	
TOTAL		7	2	22	20	15	43	33	22	40	179	115	39
Juvenile	dist. tibia	1	3		5	8		6	11		36	26	
	dist. fibula	2	0		0	2		2	3		5	8	
	calcaneum	0	6		1	9		1	15		17	54	
	dist. m/podial	5	12		19	35		27	47		137	193	
TOTAL		8	21	72	25	54	68	36	76	68	195	281	59
Subadult	prox. humerus	0	0		3	4		4	4		11	55	
	prox. ulna	0	5		2	7		3	12		9	58	
	dist. ulna	0	3		0	3		0	6		3	16	
	dist. radius	0	2		0	7		0	9		11	37	
	prox. femur	2	1		2	6		5	8		7	50	
	dist. femur	0	1		1	17		1	19		12	95	
	prox. tibia	0	3		0	6		1	11		15	54	
TOTAL		2	15	88	8	50	86	14	69	83	68	365	84
Adult				100			100			100			100

infant slaughter remained just as frequent (about 40%), rather fewer pigs (20% compared with 28%) may have been slaughtered as juveniles and rather more (25% compared with 15%) as subadults during the later period. The subsamples for Periods 3A and 3B are insufficiently large to permit any further refinement of this suggestion.

Table 22.7. Eruption and wear data for some pig mandibular teeth

| Tooth	dp4	P4	M1	M2	M3
Age	4 wks	16 mths	6 mths	13 mths	25 mths
	a	-	C	-	-
	b	-	C	-	-
	b	-	V	-	-
	b	-	1/2	-	-
	b	-	1/2	-	-
	b/c	-	U	C	-
	c	-	a	-	-
	c	-	a	C/E	-
	c	-	a	V/E	-
	-	-	a	C	-
	d	-	a	C	-
	d/e	-	U	-	-
	d	-	a	-	-
	d	-	a	V/E	-
	d	-	a	1/2	-
	e	-	a	C/V	-
	-	-	a	a	-
	f/g	-	a	-	-
	e	-	b	-	-
	e	-	b	-	-
	-	-	b	C	-
	g	-	b	E	-
	g	-	b	a	U
	-	U	b/c	-	-
	-	-	b	a	C
	-	-	-	a	V
	-	-	b	a	V
	-	-	-	a	V
	-	-	-	a	V
	-	-	-	a	1/2
	-	a	b	a	-
	-	-	b	a	-
	-	-	b/c	a	-
	-	-	b/c	a	-
	-	a	c	-	-
	-	a	c	-	-
	-	-	c	a	-
	-	-	c	a	-
	-	-	c	a	-
	-	-	c	a	-
	-	-	c	a	-
	-	a	c	b	U
	-	b	c	b	U
	-	-	c/e	b	-
	-	b	d	a	U
	-	-	d	b	-
	-	-	-	b	a
	-	-	-	b	d
	-	b	d	-	-
	-	-	-	c	a
	-	-	d	c	-
	-	b	d	c	-
	-	1/2	e	-	1/2
	-	a	e	-	-
	-	a	e	b	a
	-	-	f	c	-
	-	a	f	d	c
	-	-	-	e	b/c
	-	e	g	-	-
	-	d	h	-	-
	-	f	h	-	-
	-	f	j/k	g/h	-

Single Teeth:
dp4 U,b,c,c/d,d,d,d,e,e,e. (+ 7 with no eruption/wear data)
P4 a/c,b,b,b. (+ 10 with no eruption/wear data)
M1 a,a,b,b,b,c,c,c,c,c,c,d,d,d,e,e/f,g.
M2 V/E,a,a,a,a,g.
M3 1/2,U,a,a,a,a,a,a,a,a,a,a,a,a,a,a,a,a,a,b,b,b,c,c,c.

Since pigs are prolific breeders and very young pigs can gain weight extremely rapidly, the slaughter of a high proportion of individuals before their growth rate declines to a relatively slow rate ensures that the population remains young and highly productive (of biomass). Thus, the continuing high incidence of infant slaughter from Period 3 to 4 indicates that productivity was an ongoing concern of pig management at Kissonerga. However, if the shift in emphasis, suggested above, from juvenile to subadult culling of those pigs which were permitted to live beyond infancy did indeed occur, this would seem likely to have detracted somewhat from the energetic efficiency of pig exploitation.

Mandibular dental fragments of pig suggest a broadly similar picture of pig mortality for the assemblage as a whole, and chronological subdivision of the material reveals no particular trends. Eruption and wear data are presented in Table 22.7, using the scheme of Grant (1975). Suggested ages at eruption are derived from Silver (1969, Table G) and Matschke (1967).

The fourth deciduous premolar had not yet been replaced by the permanent tooth in 37 instances out of 68, suggesting that 54% of pigs had died by about a third of the way through their second year. This figure accords well with the epiphysial estimate of 58% dead by 2-2.5 years and may indicate that juvenile culling was concentrated at the beginning of that stage, continuing the high frequency of infant culling. The wide spread of wear stages on dp4s suggests that culling of pigs generally occurred from about the time that the tooth began to exhibit wear (probably *c.* 2-3 months) throughout the infant and early juvenile stages, and was not concentrated at any particular time within this agespan.

Lower third molars provide evidence that only a minority of pigs at Kissonerga survived much beyond about 2-2.5 years of age (i.e. the end of the juvenile stage); of 42 specimens with recordable eruption/wear data, 33 were not even sufficiently worn that dentine was exposed and the other 9 displayed only light wear. The small proportion of P4s and M2s with more than very light wear confirms that very few pigs survived into adulthood. None of the mandibular specimens in-
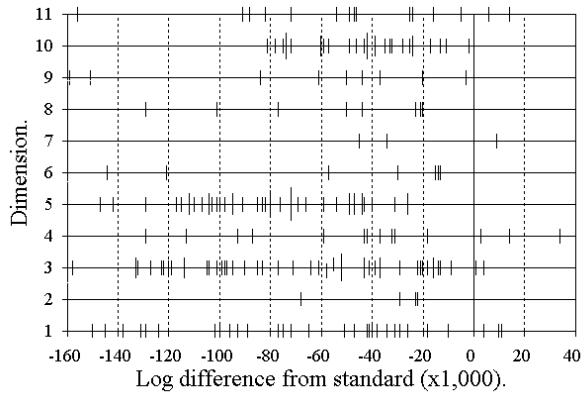
Dimensions and standard values (mm): 1 distal scapula (GLP=42.8), 2 proximal humerus (Bp=59.1), 3 distal humerus (Bd=48.8), 4 proximal ulna (LO=70.6), 5 proximal radius (Bp=36.2), 6 distal radius (Bd=40.3), 7 proximal femur (Bp=65.5), 8 distal femur (Bd=51.3), 9 proximal tibia (Bp=57.9), 10 distal tibia (Bd=34.1), 11 calcaneum (GL=90.0). Standard is European wild boar male H 12 271 in the Museum of Zoology, University of Cambridge.

Fig. 113: Pigs. Dispersion diagram

cluded in Table 22.7 indicate advanced age, but three maxillary dental specimens display heavy wear, su g-gesting that occasional pigs were allowed to live on into advanced years.

A number of measured dimensions of fused pig bones from Kissonerga has been represented in a di s-persion diagram (Fig. 113). The numbers on the Y-axis represent particular dimensions of various skeletal el e-ments. For each specimen, the value represented on the X-axis is the difference (x1,000) between the logarithm of the recorded measurement and of the equivalent value for a standard, which is, in this case, the skeleton of a European wild boar (male). The smaller size of most of the Kissonerga pigs than this standard animal is clearly apparent, suggesting that the great majority of the Kissonerga pigs which survived beyond the age of fusion of even the distal tibia and the calcaneum (probably around 2-2.5 years) were females. If, as seems quite probable, the break in the distribution of points between -5 and -9 represents a dividing line b e-tween males and females, then females which were permitted to live beyond this age outnumbered males by about 10:1.

§ 22.4.3 Caprines

Of a total of 1,662 caprine postcranial fragments, 358 could be identified to the genus level, and of these 316 (88%) were goat and 42 (12%) were sheep. Sheep was further represented by 2 horncore fragments and goat by 42 horncore and 4 other cranial fragments.

One means of distinguishing sheep from goats is by considering the length of the neck of the caprine sca p-ula in proportion to its width (Boessneck *et al.* 1964). A plot of the appropriate dimensions is presented in Fig. 114. Most of the points (n=13 + 1 interpolated) lie

above the line representing the upper limit of slende r-ness for sheep and are clearly goat scapulae. Three fall below the range for goat, and must represent sheep, and three could represent either sheep or goat. If these a m-biguous specimens are, in fact, goats, this would su g-gest a 15% incidence of sheep in the caprine popul a-tion, which conforms well with the overall estimate of 12%, quoted above. However these indeterminate points are interpreted, it is clear that amongst the Ki s-sonerga caprines, goats constituted the great majority. This was also found to be the case in the broadly co n-temporary bone assemblage from nearby Lemba (*LAP* I, 296).

Examination of the chronological occurrence of sheep remains suggests the possibility that they were rare or even absent from Kissonerga prior to Period 3B. Of a total of 153 identified caprine remains which may be attributed, with greater or lesser confidence, to P e-riod 3A or earlier, only 2 were identified as sheep (compared with 25 goat), and both of these come from potentially contaminated contexts.

In Period 3B, 16% of 32 postcranial caprine r e-mains which were identified to genus were of sheep, and in Period 4 the figure was 10% of 234. For Period
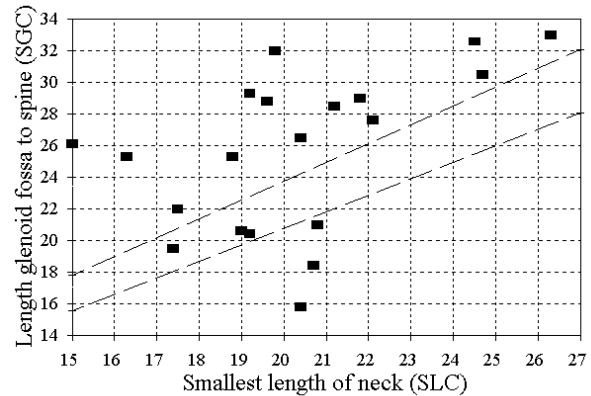
NB The upper line represents the upper limit of slenderness for sheep, while the lower line represents the lower limit for goat.

* Smallest distance between base of distal end of spine and cranial margin of glenoid cavity (SGC) taken after Boessneck *et al.* 1964, 58 and diagram 1)

Fig. 114: Caprine scapula. SGC* x SLC

5 only 9 postcranial caprine remains were attributable to genus, and of these 3 (33%) were sheep. These o b-servations suggest an increase in the proportion of sheep amongst the caprines in Period 5, although the small size of the samples (particularly for Period 5) upon which the observations are based prompt caution in accepting this conclusion.

One goat bone (from pit fill 620, a Period 4 context of reasonable reliability) which merits particular me n-tion is the medial portion of a small horncore which exhibits a slight degree of twisting. So far as the writer is aware, all other pieces of goat horncore from Ne o-

Table 22.8a. Mortality of goats, based on epiphysial fusion and taking the assemblage as a whole

Stage	Element	Number fused	Number unfused	% dead by end of stage
Infant	dist. scapula	32	8	
	dist. humerus	98	38	
	prox. radius	74	1	
TOTAL		204	47	19%
Juvenile	dist. tibia	61	16	
	dist. m/podial	40	30	
TOTAL		101	46	31%
Subadult	prox. humerus	22	15	
	prox. ulna	20	40	
	dist. ulna	3	0	
	dist. radius	26	32	
	prox. femur	37	14	
	dist. femur	34	37	
	prox. tibia	36	16	
	calcaneum	24	21	
TOTAL		202	175	46%
Adult				100%

lithic and Chalcolithic Cyprus are of the untwisted "scimitar" type, displaying no hint of the helical twist which is so characteristic of the more developed forms of the domestic goat (Clutton-Brock 1981, 61; Zeuner 1955). Torsion in goat horncores is usually regarded as a mutation which resulted from modified selective pressures upon goats quite early on in the process of domestication (Hole *et al.* 1969, 277-278). However, since a slight degree of torsion is not unknown in the horns of the Western Asiatic wild goat (*Capra aegagrus*), the increasing frequency and amplitude of this characteristic amongst their domestic descendants should perhaps be viewed as the development of a pre-existing character (Ducos and Helmer 1981, 523). Whatever the details of the origin of the trait, by the time of the later Chalcolithic in Cyprus, the twisted horncore has become the norm among domestic goat populations in mainland Western Asia. Although this is not necessarily the case, it may be that the twisted horncore from Kissonerga reflects changes in selective pressures upon goats in the later part of the Chalcolithic period. Indeed, the possibility is suggested below that goat management underwent a change in Period 4. The apparent rarity of twisted goat horns at this time in Cyprus, and the fact they do not seem to have occurred earlier, are probably due to differences in the selective pressures to which the goats were exposed on the mainland and in the insular situation of Cyprus.

Mortality patterns for the Kissonerga goats may be deduced from epiphysial fusion data; figures are presented for the assemblage as a whole (Table 22.8a) and for four chronological subsamples (Table 22.8b). Although the samples include undifferentiated caprine material as well as items which could be attributed specifically to goat, the relative rarity at Kissonerga of bones which could be attributed to sheep suggests that only a minimal amount of sheep material, if any, will have been included in these samples, which should, therefore, reflect the situation for goats.

Table 22.8b. Mortality of goats* in Periods 3A, 3B and 4, based on epiphysial fusion

Stage	Element	Period 3A			Period 3B			Period 3			Period 4		
		F	UF	%	F	UF	%	F	UF	%	F	UF	%
Infant	dist. scapula	1	0		1	1		4	2		17	4	
	dist. humerus	6	1		5	1		11	2		62	16	
	prox. radius	6	0		6	0		12	0		50	1	
TOTAL		13	1	7	12	2	14	27	4	13	129	21	14
Juvenile	dist. tibia	3	3		6	2		11	6		33	7	
	dist. m/podial	4	4		4	6		8	11		20	15	
TOTAL		7	7	50	10	8	44	19	17	47	53	22	29
Subadult	prox. humerus	0	3		1	2		1	5		16	10	
	prox. ulna	1	1		1	3		2	4		15	26	
	dist. ulna	0	0		0	0		0	0		3	0	
	dist. radius	0	4		5	3		6	7		18	17	
	prox. femur	0	1		0	1		0	2		30	11	
	dist. femur	1	4		1	2		3	6		28	24	
	prox. tibia	3	3		2	1		7	5		21	7	
	calcaneum	1	3		2	2		3	5		18	13	
TOTAL		6	19	76	12	14	54	22	34	61	149	108	42
Adult				100			100			100			100

* Including items identified as undifferentiated caprine, but excluding those specifically identified as sheep.

Overall 19% of the Kissonerga goats died as infants of younger than a year old. During the juvenile stage, at over a year but less than 1.5-2.5 years of age, 12% were slaughtered, whilst a further 15% died during the su c-ceeding subadult stage. Thus, 54% of the Kissonerga goats survived beyond 2.5-3.5 years of age to be slaughtered as adults.

**Table 22.9.** Eruption and wear data for some caprine mandibular teeth

Tooth	dp3	P4	M1	M2	M3
Suggested age	0-6	24	3	12	24
at eruption	wks	mths	mths	mths	mths
	g	-	b	-	-
	f/g	-	d	C	-
	-	-	-	c	C
	g	-	d	-	-
	g	-	d	-	-
	k	-	h	f	-
	-	-	-	f	b/c
	-	c	h	g	-
	-	h	h	f	d/e
	-	g	h	g	d
	-	g	h	-	-
	-	h	h	-	-
	-	-	h	h	d
	-	h	h	h	-
	-	h	i	-	-
	-	h	i	-	-
	-	h	k	-	-
	-	h	k	h	g
	-	h	k	h	-
	-	h	l	-	-
	-	-	-	h	h
	-	h	n	h	j
	-	i	j	-	-
	-	i	n	-	-
	-	i	n	h	-
	-	h	k	h	g/h
	-	-	-	h	g/h
	-	l	n	h	j

Single Teeth:
dp3   e,g,g,g,g. (+ 1 with no eruption/wear data)
P4   c,g,g,h,h,h,i. (+ 6 with no eruption/wear data)
M1   d,f,g,i,k.
M2   f,f.
M3   b,c,c,g,h,h,i,j,j,j,j.j

Of the chronological subsamples presented in Table 22.8b, those for Periods 3A and 3B are too small to be trustworthy. The undifferentiated Period 3 subsample is hardly large enough to inspire enormous confidence, but does tend to suggest a degree of deviation from the pattern apparent from the much larger Period 4 su b-sample. It would seem that juvenile culling was much less frequently practised in the later period (15% co m-pared with 34% in Period 3), and that concomitantly more goats survived into adulthood (58% compared with 39% in Period 3). A change in goat management may be indicated, but its significance remains obscure.

Eruption and wear data for caprine mandibles from Kissonerga are presented in Table 22.9. The stages utilised are those of Payne (1973), beginning with "a" for first stage (enamel wear only). The presence of 11
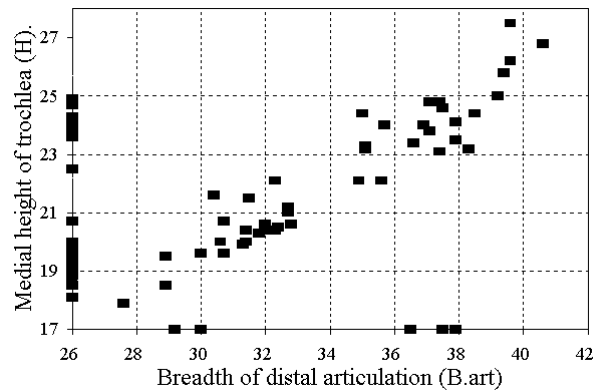
Medial height of trochlea of distal humerus taken after Ducos (1968, 175) and breadth of distal articular surfaces taken after Legge (1981, Fig. 58B).

Fig. 115: Caprine humerus. H x B.art

specimens of dp3 and 32 of P4 suggests a 26% morta l-ity rate before the age of two years i.e. towards the j u-venile/subadult transition in fusion terms, which a c-cords well with the figure of 31% dead by the end of the juvenile stage which has been established for the assemblage as a whole (Table 22.8a). Of 22 erupted lower third molars for which eruption and wear data exist, 7 are in full wear (defined by Payne's 10th wear stage) and 15 exhibit lesser degrees of wear. This su g-gests that those caprines which survived into adulthood were generally culled as young adults. The dental data are insufficient to permit meaningful subdivision along chronological lines.

Fig. 115 presents a plot of the breadth of the distal articulation (B.art) of fused caprine humeri against medial height (H). None of the specimens included was specifically attributed to sheep, a few were attributed to goat and at least the great majority may be presumed to be goat. The distribution of points clearly separates into two clusters, which must represent males (larger) and females (smaller). The similar number of points in each cluster suggests that those goats which survived beyond a year of age included roughly equal numbers of males and females.

Size distributions of selected dimensions of mature specimens of later fusing elements of Kissonerga goats, presented in Fig. 116, suggest that males and females survived to adulthood in equal numbers. The elements represented (as has been demonstrated for the distal end of the humerus in Fig. 115) exhibit a considerable degree of sexual size dimorphism. The vertical lines in the size distributions represent the divisions between males and females suggested by a previous study by the writer of prehistoric Cypriot caprine bones (Croft 1988a). The apparent retention of a high proportion of adult males (overall 34 males compared with 35 f e-males represented in Fig. 116) is noteworthy. Most of these males would have been surplus to breeding r e-quirements, and their presence as such a high propo r-

43	45	47	49	51	53	55	57	|	59	61	63	65 mm	
F			F		F			|			M		Ulna
F			F		F	F		|	M	M	M	M	Length of olecranon process (LO)

39	41	43	45	47	|	49	51	53 mm	
					|	M			
					|	M			Calcaneum
					|	M			Length of anterior edge
			F		|	M	M		of dorsal tubercle
			F		|	M	M		(L.ant.)**
F	F	F	F		|	M	M	M	

38	40	42	44	|	46	48	50	52	54 mm	
		F		|						
		F		|						Femur
	F	F		|			M			Distal breadth (Bd)
	F	F		|	M	M	M	M	M	

45	47	49	51	53	55	57	59 mm	
						M		
		F				M		Femur
F	F	F			M	M		Proximal breadth (Bp)
F	F	F	F		M	M		

28.5	29.5	30.5	31.5	32.5	33.5	34.5	|	35.5	36.5	37.5	38.5	39.5	40.5	41.5	42.5 mm	
					F		|									
			F	F	F		|	M								Radius
F					F	F	|	M		M	M	M		M	M	Distal breadth (Bd)

* Male specimens are represented by "M" and females by "F". The size ranges of the sexes were established by a previous metrical study of prehistoric Cypriot caprine remains (Croft 1988a), and the dotted line indicates a proposed dividing line.

** Except for L.ant., all measurements are taken according to the recommendations of von den Driesch (1976). The length of the anterior (dorsal) edge of the calcaneum from the most cranial point of the dorsal tubercle to the axial point on the lip of the articular surface for the astragalus is taken after Hué (1907, 39 & Pl. 14).

Fig. 116: Size distributions of selected dimensions of mature specimens of later fusing elements of goats *

tion of the adult population suggests a lack of concern with productive efficiency. If the observed pattern does not seem to reflect the efficient management of goats for meat production, it is even further from the expected culling pattern if milk production were an important objective (cf. Payne 1973, Fig. 2). It is worth emphasising that most of the specimens represented in Fig. 116 are attributable to Period 4, indicating that milking was not (at least at Kissonerga) a major factor in the relationship between people and goats during the later Chalcolithic.

The significance of the prominence of mature males amongst the Kissonerga goats is uncertain, and may only be guessed at. Perhaps these goats, or at least a proportion of them, were not herded, but free-living, feral animals which were hunted. If hunted goats only made a small contribution to human diet, then the incentive to exploit them in an energetically efficient way, as seems likely to have been the case for deer and pigs (discussed above), may not have been very great. The flesh of well grown goats, could conceivably have been preferred for culinary reasons, or the horned heads of mature males prized as trophies. Even if the goats were herded, it is possible that their management was geared more to social than nutritional ends (Croft 1991, 74; Keswani 1994).

§ 22.4.4 Cattle

Cattle remains were not abundant at Kissonerga, being represented by 51 identified pieces. Fourteen pieces of cattle bone were unstratified, and of the 37 that could be more or less confidently attributed to a chronological period, 29 belong to Period 5. Of the remaining 8 pieces, all but one derive from Period 4 contexts which were recognised as contaminated.

Only one piece of cattle bone at Kissonerga came from a pre-Period 5 context which was not judged to be contaminated. This was a distal humerus from general deposit 815, a Period 4 context which was considered to be of standard reliability. However, since 815 was an

extensive, superficial ashy deposit, the risk of some contamination by later material is considerable, and even though the ceramic assemblage and other artefacts from this unit betrayed no evidence of this, the chronological distribution of cattle remains on the site favours the idea that the single cattle bone from 815 is intrusive.

The Kissonerga evidence thus accords with the observation that cattle do not occur in Cyprus after the Aceramic Neolithic (Guilaine *et al.* 1995, 30) and prior to the beginning of the Bronze Age. Their significant level of abundance (7%) in the small Period 5 animal bone sample (Table 22.10c) shows that relatively soon after the end of the Chalcolithic period, recently introduced cattle had become an important component of the animal economy (Croft 1996, 222).

The Kissonerga cattle remains are generally fragmentary, and little of the material was measurable. Considered as a single group, the material gives the overall impression of small stature. Three measurable astragali have greatest (lateral) length measurements of 72.0, 70.8 and 56.9 mm, and two naviculocuboids have greatest breadths of 49.2 and 43.7 mm.

§ 22.4.5 Equid

An upper molariform tooth was the only equid bone identified from Kissonerga. It came from general deposit 774, a Period 4/5 context, so it may reflect the presence of equids at Kissonerga in Period 5. However, since this context was recognised as being contaminated, the date of this single equid bone is very much open to doubt. Although equid remains have been reported from pre-Bronze Age Cyprus (Schwartz 1973, 217; 1974a and b; Zeuner and Grosvenor Ellis 1961, 236), in the writer's opinion these reports are unreliable (Croft 1988a).

§ 22.4.6 Dog

Occasional dog remains, amounting to a total of 33 fragments, are known from contexts of at least standard reliability for Periods 2, 3A, 3B and 4. Few bones were measurable, but the Kissonerga material seems, on the whole, to represent robust, medium-sized dogs. Surprisingly, damage to faunal remains consistent with dog chewing was not noted.

§ 22.4.7 Cat

Cat remains were occasionally encountered in contexts of at least standard reliability in Periods 3A, 3B and 4, and amount to a total of 16 fragments. The cats of Kissonerga perhaps tended to be slightly larger than modern *Felis catus* in Cyprus, although the sample is too small to substantiate this generalisation adequately.

§ 22.4.8 Fox

Fox is represented with moderate frequency from Period 2 onwards at Kissonerga, a total of 210 fragments

having been identified. Unlike the other small carnivores, the fox was probably not resident on the site, and foxes would most likely have been brought there dead, having been hunted or trapped away from the settlement. A wide range of skeletal elements is sufficiently abundantly represented (Table 22.4d) to suggest that whole skeletons of foxes were being disposed of on the site. Foxes were presumably killed mainly for their pelts, and were brought back for skinning, although it is not impossible that their flesh was also eaten.

§ 22.4.9 Hippopotamus

A semi-fossilised lower first molar tooth was the only item which was attributable to the Cypriot pigmy hippopotamus (*Phanourios minutus*). It was found in Unit 1292, the lower fill/occupation deposit in B 1103 of Period 3B. The fact that this tooth was covered in a hard white crystalline encrustation, quite unlike the granular grey encrustation commonly found on other animal bones from Kissonerga, sets it apart. This tooth was clearly brought into the settlement as a fossil, in the same way that a hippopotamus distal metacarpal seems to have been introduced to the Aceramic Neolithic settlement at Cape Andreas-Kastros (Davis 1987, 308; 1989, 193). It may well have been collected as a curio, millennia after the extinction of hippopotami on Cyprus, from fossiliferous deposits known to exist nearby (Held 1992, 38).

§ 22.4.10 Marine mammals

Two single teeth represent marine mammals. Firstly, a cetacean (whale) tooth came from an unstratified context and has not been more closely identified. A second tooth (from surface 1255 of Period 4) represents a marine carnivore, probably the Monk Seal (*Monachus monachus*).

§ 22.4.11 Birds

Bird remains were encountered in contexts of periods 2-4, and of 107 pieces recovered, 48 proved identifiable. The fact that 32 of these pieces of bird bone were recovered by wet sieving, suggests that the overall recovery rate for bird remains has been very poor indeed (Table 22.3).

Secure identification of the full range of bird remains from Kissonerga is rather more problematic than for the mammalian bone. According to a recent check-list of the Cyprus Ornithological Society, 360 avian taxa have been commonly or occasionally observed in Cyprus in recent years and presumably at least as wide a selection of birds existed during the early Holocene. By comparison, a very limited range of mammalian species is known from Early Prehistoric sites on the island. The difficulty (often impossibility) of separating closely related avian taxa on the basis of small samples of fragmentary osteological remains from archaeological sites exacerbates the problem of identification, even

assuming access to an adequate reference collection.

Fortunately, a large proportion of the Kissonerga bird remains represents taxa which are common at the present day, and thus readily identifiable. Other taxa than those which have been identified are also clearly present, but it has thus far not proved possible to identify them with a satisfactory level of confidence. Further work is therefore required to maximise the yield of information from the Kissonerga bird bone assemblage, and the results presented here must be viewed as incomplete.

A majority of identifiable bird remains was attributable to various species of pigeon. Most abundant was woodpigeon (*Columba palumbus*), represented by 16 fragments and rock dove (*Columba livia*) represented by 15 fragments, remains of both taxa deriving from 13 separate contexts. A third pigeon species, turtle dove (*Streptopelia turtur*), was represented by 5 fragments from as many different contexts.

Another group of birds represented by multiple specimens in the Kissonerga assemblage are the ducks. One specimen was attributed to mallard (*Anas platyrynchos*) and three others almost certainly represent other species of duck.

The writer's tentative identification of song thrush (*Turdus philomelos*) from Ceremonial Area pit 1225 (*LAP* II.2, 73) has, in the light of comparison with a wider range of reference material, been confirmed and a second fragment from the same context is now viewed as most probably representing the same taxon.

Other birds which could confidently be identified on the basis of single specimens are quail (*Coturnix coturnix*), coot (*Fulica atra*) and jay (*Garrulus glandarius*).

Several lower order identifications (which may in time be improved with reference to a wider range of comparative material) on single specimens are worth mentioning here in order more fully to indicate the diversity of the Kissonerga bird remains. A fragment of a large wader probably represents crane (*Grus grus*). A fragment of a large Accipiter probably represents one of the larger vultures of the region (i.e. larger than griffon vulture). Finally, a single fragment represents one of the larger owls.

The comparative fragility of bird bones suggests that only a small proportion of those which were brought onto the site will actually have survived. Furthermore, it has been estimated (Table 22.3) that the overwhelming majority (97%) of bird remains preserved at Kissonerga has been overlooked. Thus, the not inconsiderable quantity of bird remains which was recovered and the diversity of taxa identified will certainly represent merely the tip of the avian iceberg. It seems clear that birds will have constituted a far more significant resource than first appearances might suggest.

§ 22.4.12 Microfauna

House Mouse (*Mus musculus*)

Several hundred rodent bones were retrieved from Kissonerga, mainly from the wet sieve. They occurred quite commonly in contexts dating to Periods 2-4, but were not recovered from Periods 1 or 5. The rodent remains included 52 upper incisors which each possessed a subapical notch which is characteristic of house mouse (*Mus musculus*) (Harrison and Bates 1991, 251). The other rodent remains do not provide evidence for the presence of any other species at Kissonerga.

The great majority of the mouse bones came from pit and grave contexts, although other types of context, especially building fills and wall collapse deposits, also yielded mouse remains. Presumably pits and graves provided useful sources of food, and easy burrowing conditions and open steep-sided pits would also have functioned as "pit-traps" into which mice and other small creatures fell and from which they could not escape.

Although some of the rodent remains may well be intrusive, a dozen burnt fragments dating to all Periods from 2-4, confirm the presence of mice during the occupation of the settlement. This evidence is corroborated by the existence of half a dozen animal bones which bear traces of rodent gnawing. These items include caprine, pig and deer phalanges and a pig metapodial, and date to Periods 3B and 4.

Lesser White-toothed Shrew (*Crocidura suaveolens*)

Thirteen fragments, all retrieved by wet sieving, were attributed to the Lesser White-toothed Shrew (*Crocidura suaveolens*). Shrew remains came mainly from pits, and the 10 contexts which yielded them date to Periods 2-4 and also contained mouse remains.

Amphibians

Several dozen fragments of frog or toad bone derive from 18 contexts dating from Periods 2-4. Amphibian remains came mainly from pits, for which fact the pit-trap effect is probably responsible.

Reptiles

Like other microfaunal remains, the several dozen reptile bones which were found tended to come from pits, but also occurred in a variety of other contexts. They come from contexts which date to Periods 2-4, but as ever with burrowing microfauna, it is likely that many of them are not contemporary with the archaeological deposits in which they occur, but represent later, intrusive material. One reptile vertebra was burnt.

The Kissonerga reptile remains have not been studied in detail, but it is clear that they consist overwhelmingly of a variety of lizards. Many bones compare with *Stellio stellio* , but others clearly derive from

Table 22.10. Identified bone fragments of the main animals by period - including uncertain attributions to period and low quality contexts

a. Periods 3A, 3B and 4 raw counts

Period	Deer		Pig		Caprine		Cattle		Total
	n=	*%*	*n=*	*%*	*n=*	*%*	*n=*	*%*	
3A	409	55.5	196	26.6	132	17.9	-	-	737
3B	483	37.1	626	48.1	191	14.7	-	-	1,300
4	2,497	37.7	2,877	43.5	1,241	18.8	-	-	6,615
Total	3,389		3,699		1,564		-	-	8,652

b. Periods 3A, 3B and 4. Adjusted Counts

Period	Deer		Pig		Caprine		Cattle		Total
	n=	*%*	*n=*	*%*	*n=*	*%*	*n=*	*%*	
3A	327	62.0	93	17.6	107	20.3	-	-	527
3B	415	46.6	327	36.7	149	16.7	-	-	891
4	2,143	42.0	1,905	37.4	1,049	20.6	-	-	5,097
Total	2,885		2,374		1,305		-	-	6,515

c. Period 5. Raw and adjusted counts

Count	Deer		Pig		Caprine		Cattle		Total
	n=	*%*	*n=*	*%*	*n=*	*%*	*n=*	*%*	
Raw counts	167	45.4	103	27.9	71	19.2	28	7.6	369
Adjusted counts	140	48.9.	62.5	21.8	63	22.0	21	7.3	286.5

other saurian species. A single snake mandible was present.

§ 22.5. Faunal change through time

Changes in the animal economy at Kissonerga might well be expected to be reflected in changes through time in the relative importance of the main economic animals. Period 1 yielded no identifiable animal re-mains and only 20 may be even tentatively attributed to Period 2. Periods 3A, 3B and 4, however, all have suf-ficient quantities of animal remains to be potentially useful in the study of long-term change. Since the time-span represented by these three periods is lengthy, probably amounting to about a thousand years, a degree of change in subsistence practice would seem quite likely to have occurred.

Only 7 identifiable bone fragments could be firmly attributed to Period 5, although a considerably larger quantity (340 fragments) was attributable to this period with a lesser degree of confidence. Thus, although not ideal, the Period 5 sample also has something to offer to an assessment of subsistence change.

The raw counts of identified fragments by period (Table 22.10a) are indeed suggestive that the animal economy at Kissonerga did not remain static through-out this long span of time. It appears that the relative importance of deer declined substantially and pigs un-derwent a concomitant increase, whilst the frequency of caprine bones remained fairly stable. This is a situation which clearly merits closer examination, but for a vari-ety of reasons the raw counts of identifiable fragments are unsuitable for this purpose, since they contain a number of potentially serious inherent biases conse-quent upon the anatomical differences between pigs and ruminants.

Whilst the ruminants may possess either antlers or horncores, the pig possesses no comparable structure. On the other hand, pigs have more teeth than rumi-nants and their skulls tend to fragment into a greater number of identifiable fragments. The larger number of bones in the foot of the pig also provides a potential source of bias which will tend to inflate the apparent importance of pigs compared with ruminants if the as-sessment is based on fragments counts. Pigs possess four metapodial bones per limb, to each of which is attached a digit, whilst deer and caprines have only a single functional metapodial (cannon) bone, which bears two digits. The digits of all of these animals con-sist of three phalanges. Thus, pigs have twice as many phalanges and four times as many metapodia as deer or caprines. Finally, pigs possess a fibula, which is lack-ing in the ruminants.

In order that figures for the abundance of identified fragments of the main economic animals at Kissonerga may more meaningfully be compared, raw counts have been adjusted in the following ways:

1) All cranial material has been excluded.
2) Pig metapodia ii and v and their (accessory)

phalanges have been excluded.

3) Numbers of pig metapodia iii and iv have been halved (so adjusted counts of pig bones are not always expressed as whole numbers, but may include 0.5 of a bone).

4) Pig fibulae have been excluded.

An assessment based on raw counts of identified fragments (given in Table 22.1) would suggest an overall relative abundance amongst the main animals represented at Kissonerga of deer 39.8%, pig 42.0% and caprines 18.2%. However, for reasons suggested above, such an assessment would almost certainly be erroneous. A similar assessment based on adjusted counts (given in Tables 22.4a-c), deemed more reliable, yields figures which differ considerably, viz. deer 44.9%, pig 35.1% and caprines 19.9%. Minimum Numbers of Individuals suggest proportions of deer (MNI 136) 45.3%, pig (MNI 97) 32.3% and caprines (MNI 67) 22.3%, and although MNI's may, on the whole, be less satisfactory than some sort of fragments count as a basic unit of faunal quantification, the fact that these figures are closely similar to those based on adjusted fragments counts may reflect the reliability of the latter.

Adjusted counts of identified fragments of the main economic animals by chronological period are given in Table 22.10b. These differ quite significantly from the raw counts (Table 22.10a) and are, as explained above, to be preferred for the purpose of documenting trends through time in the animal economy of Kissonerga. Like the raw counts, the adjusted counts indicate a decline in the relative abundance of deer and an increase in that of pigs through time. Whichever type of count is used, a major contrast is apparent between Periods 3A and 3B, whilst the representation of the main animal taxa in Periods 3B and 4 are not greatly dissimilar. Adjusted counts suggest that the changes observed between Periods 3A and 3B continued, albeit at a greatly reduced rate, between Periods 3B and 4.

The figures presented in Tables 22.10a and b are maximal ones in that they include material from potentially contaminated contexts, and contexts which could be attributed to a period only with a low degree of confidence. Ideally the search for diachronic patterning in the faunal assemblage should be based on material from prime contexts for which mixing with even near-contemporary material is judged to be unlikely, but such contexts are, unfortunately, relatively uncommon. Adjusted counts of identified animal remains from such contexts are presented in Table 22.11a, but it is apparent that the samples for Periods 3A and 3B are too small to inspire confidence.

If consideration is also taken of material from reasonably good, but less secure contexts (that is contexts which do not appear to have been contaminated but which may include an admixture of residual material; that is to say standard contexts for a long lived and

archaeologically complex settlement site), then sample sizes may be boosted very considerably without, perhaps, compromising sample reliability to an unacceptable degree. Figures for the abundance of the main economic animals in pooled samples for "prime" and "standard" contexts are given in Table 22.11b, and of the four sets of figures for relative taxonomic abundance it seems probable that these are, overall, the most reliable. According to these figures the major contrast is still between Periods 3A and 3B, with deer declining and pig increasing in relative abundance, and these trends now appear fractionally more clearly to continue between Periods 3B and 4.

Table 22.11. Identified bone fragments of the main animals by period

a. Periods 3A, 3B and 4. Adjusted counts, prime contexts only

Period	Deer		Pig		Caprine		Total
	n=	*%*	*n=*	*%*	*n=*	*%*	
3A	38	57.1	15.5	23.3	13	19.5	66.5
3B	46	45.5	38	37.6	17	16.8	101
4	319	35.7	375.5	42.1	198	22.2	892.5
Total	403		429		228		1,060

b. Periods 3A, 3B and 4. Adjusted counts, prime and standard contexts

Period	Deer		Pig		Caprine		Total
	n=	*%*	*n=*	*%*	*n=*	*%*	
3A	148	59.9	43	17.4	56	22.7	247
3B	281	47.6	208.5	35.3	101	17.1	590.5
4	1,821	42.6	1,578.5	36.9	878	20.5	4,277.5
Total	2,250		1,830		1,035		5,115

Notwithstanding the conclusion that the figures for relative taxonomic abundance given in Table 22.11b should be, overall, the most reliable, the figures for Period 4 given in Table 22.11a, generated from a substantial sample of animal remains from more than a hundred different purely prime contexts, should be the most reliable available for this period. As pointed out above, the samples from prime contexts of Periods 3A and 3B are too small to be dependable. It will be noted that that the inclusion of Period 4 material for which a degree of mixing is likely (i.e. that from "standard" contexts) gives a somewhat inflated impression of the relative abundance of deer and deflates that of pigs and caprines (Table 22.11b). This is probably due to a combination of two main factors. Firstly, the inclusion of residual material is liable to bias the Period 4 sample in favour of deer since it seems apparent that deer remains were relatively more abundant in earlier periods. Secondly, the greater average durability of the bones of deer than those of pigs or caprines will increase the chances that deer remains will survive redeposition to occur as residual material in later contexts.

As stated above, the figures for relative taxonomic

abundance given for Periods 3A and 3B in Table 22.11b seem likely to be the best available, and although the possibility exists that they give a somewhat inflated impression of the abundance of deer, this is less likely to be the case than for Period 4, for which the figures given in Table 22.11b are to be preferred. To summarise the trends which may be inferred, they are a constant steep decline in the relative abundance of deer remains (from 60% to 36%) throughout the time-span represented by Periods 3A, 3B and 4, and a concomitant increase in the relative abundance of pig remains (from 17% to 42%). The relative abundance of caprine remains fluctuates around the 20% level, but a period of somewhat depressed relative frequency may be indicated in Period 3B.

Taxonomic frequencies for the Period 5 animal bone sample are presented in Table 22.10c. The sample for this period derives very largely from insecure contexts and it will be observed that it is, moreover, rather small. In view of these circumstances the temptation must be resisted to compare it with those from Periods 3A, 3B and 4 other than tentatively and in the broadest terms.

It has been argued above that cattle were not present at Kissonerga prior to Period 5, and during this period they represent about 7% of animal bones (based on adjusted counts). Caprines seem to occur in Period 5 with similar frequency to previous periods. The possibility

has been noted above that sheep may have increased in importance compared with goats, but the latter retain their predominance amongst the caprines. It would be unwise to place too much reliance on these Period 5 figures, but the possibility is indicated of a somewhat increased frequency of deer remains and a considerable decrease in pig by comparison with Period 4.

§ 22.6. The spatial distribution of the faunal remains

In order to test for variability in the distribution of animal remains on the site, the proportions of the main animal taxa amongst faunal remains from pits and from grave fills was compared with their proportions in the remainder of the assemblage. This was done for the assemblage as a whole and for the Period 4 assemblage, this being the only large single-period assemblage (Table 22.12). In both cases the taxonomic composition of the pit and grave-fill assemblages was found to be closely similar to that of the remainder of the assemblage, suggesting that the composition of samples from pit and grave-fill contexts does not differ notably from that of samples from other types of context. Thus, animal remains deposited as rubbish in pits seem not to differ from those which form part of the general rubbish which occurred around the settlement. Animal

Table 22.12. Taxonomic composition of bone samples from various contexts

Taxon	Whole site	All Graves	All Pits	Period 4 Graves	Period 4 Pits	Period 4 Other
Deer	39.8%	38.7%	39.0%	37.7%	38.3%	37.4%
Pig	42.0%	46.6%	42.2%	48.0%	42.6%	43.8%
Caprine	18.2%	14.8%	18.8%	14.3%	19.1%	18.8%
n=	10,988	398	1,507	308	1,099	5246

Table 22.13. Taxonomic composition of bone samples from building and non-building contexts

Taxon	All Buildings	All Other	All Period 3 Buildings	Period 3 Other	B 1016	Other Period 3 Buildings
Deer	38.6%	40.0%	54.5%	40.5%	60.8%	49.8%
Pig	43.7%	41.7%	29.5%	43.5%	22.5%	34.7%
Caprine	17.7%	18.3%	16.0%	16.0%	16.7%	15.5%
n=	1,780	9,208	519	1,716	222	297

Taxon	All Period 4 Buildings	Period 4 Other	B 3	B 706	B 866	Other Period 4 Buildings
Deer	32.0%	38.8%	40.9%	35.2%	22.7%	29.1%
Pig	49.6%	42.5%	38.0%	35.2%	64.7%	54.1%
Caprine	18.4%	18.7%	21.1%	29.6%	12.7%	16.8%
n=	1,261	5,392	350	88	150	673

bones from grave fills were not, apparently, deliberately deposited and consist exclusively of residual material. It is thus hardly surprising that these bones also reflect the composition of the general, ambient rubbish.

The composition of bone samples from buildings was also examined to see if it was in any way distinctive, and this line of enquiry did yield more positive results (Table 22.13) although their meaning remains obscure.

Taken as a whole, the assemblage of animal remains from occupation deposits in buildings differs hardly at all from the non-building assemblage in terms of taxonomic composition. Period 3 buildings, however, did yield a substantially higher proportion of deer remains and less pig than other Period 3 contexts, whilst the reverse appears to be true for Period 4 buildings, albeit to a lesser degree. The significance, if any, of these observations is unknown.

Only B 1016 of Period 3A and B 3, 706 and 866 of Period 4 yielded sufficiently large samples of bones to be considered on an individual basis. B 1016 yielded a somewhat higher proportion of deer remains and somewhat less pig compared with the other Period 3 buildings. Pithos House (B 3) yielded a relatively high proportion of deer bones compared with other Period 4 buildings, whilst B 866 had a notably high proportion of pig bones. Clearly, the taxonomic composition of faunal samples from buildings is quite variable, and may well reflect the use of the buildings, the diet of those who used the buildings or chronological variability. None of these various explanations is preferred here, and it may indeed be that some combination of these factors is responsible for the observed variability.

§ 22.7. Discussion and conclusions

The section above on faunal change through time (§ 22.5) has outlined long-term trends in the development of the Kissonerga animal economy. It has been argued that adjustments to the raw fragments counts are necessary in order to counteract the effects of certain inherent biases, and that the adjusted figures should permit a more reliable assessment of variations over time in the relative abundance of deer, pig and caprines, the main economic animals at Chalcolithic Kissonerga. The results of such an assessment suggest a steep decline in the relative abundance of deer and a concomitant increase in that of pig between Periods 3A and 4 (mid-fourth to mid-third millennium BC), whilst the abundance of caprines remained relatively stable. In Period 5, which corresponds with the Philia Culture (late third millennium BC), cattle occurred for the first time and the trends in the abundance of deer and pig remains which have been observed throughout the preceding millennium or so of the M and LChal appear to have been reversed.

These observed trends have been expressed in terms of the relative abundance of the remains of the various animals, without any attempt to compensate for the preservational and recovery biases which have been shown to exist at Kissonerga. However, in order more fully to understand the significance of these trends for the subsistence economies of successive human communities, it is necessary to look beyond percentage figures generated more or less directly from fragments counts.

If it is assumed that the animals were exploited mainly for their meat, it is clear that their relative abundance will not directly reflect their relative importance to the subsistence of the human community, since the different animals yield very different amounts of meat. In order to make a rough estimate of the relative importance of the various animals as providers of meat, it is first necessary to adopt some estimate of relative meat yield per individual. The figures adopted here are as follows: caprine 1.0, pig 3.0, deer 3.4, cattle 8.0. (The use of these meat yield factors has been discussed elsewhere by the writer (Croft 1988a; 1991, Table 1), with the exception that the pig is here accorded a lower factor (3.0 rather than 4.0) in an admittedly rather arbitrary attempt to take account of the high frequency of pre-adult slaughter at Kissonerga).

Secondly, it is necessary to take account of the differential recovery rates which are known to have prevailed at Kissonerga. On the basis of the figures given in Table 22.3 may be estimated that 100% of cattle remains were recovered, so a recovery bias correction factor of 1.0 is applied, reflecting the fact that no correction is necessary. For deer it may be inferred that only 42% of all remains were recovered so a correction factor of 2.4 should be applied. Factors for pig (30% recovered) and caprine (37% recovered) may be calculated on the same basis as 3.3 and 2.7.

Finally, in order to get a clearer idea of the economic significance of chronological variability in relative taxonomic abundance based on fragments counts, differences in susceptibility to attrition of the bones of the different animals should ideally be taken into account. Common sense suggests that such differences may well exist. For example, the more frequently immature bones of pig might be expected to have suffered a greater degree of attrition than those of the other main animals and the assemblages of both pig and caprine bones might be expected to be more attenuated than the deer assemblage, since deer bones are larger and more robust. However, if MNI figures are used in the way outlined in § 22.2.1 above to calculate theoretical total weights of animal remains which ought to be present for each taxon, we find that the impact of assemblage attrition does not accord with these expectations.

Including unidentified material, allocated to each taxon in proportion to the representation of that taxon in the identified fraction of the sample (data from Table 22.2), it may be estimated that taphonomic processes

Table 22.14. Adjusted fragments counts and estimated relative meat yields by period*

Period	Culture	Deer		Pig		Caprine		Cattle	
		n=	*%*	*n=*	*%*	*n=*	*%*	*n=*	*%*
3A	MChal (early)	148	59.4	43	18.1	56	22.5	-	-
	Meat supply fraction		67.8		23.8		8.4		-
3B	MChal (late)	281	47.6	208.5	35.1	101	17.3	-	-
	Meat supply fraction		49.6		44.5		5.9		-
4	LChal	319	35.5	375.5	42.5	198	22.0	-	-
	Meat supply fraction		38.1		54.1		7.8		-
5	Philia Culture	140	48.9	62.5	21.8	63	22.0	21	7.3
	Meat supply fraction		54.5		29.4		8.1		8.0

* Estimates are based on adjusted fragments counts given in Tables 22.10c (Period 5), 22.11a (Period 4) and 22.11b
(Periods 3A and 3B), and general correction factors of caprine 2.7, pig 9.9, deer 8.2 and cattle 8.0.

have resulted in the loss of 82% of deer skeletal r e-mains at Kissonerga, but of only 75% of pig remains and 66% of caprine remains. Thus, deer remains a p-pear to have suffered greater attrition than pig remains, and caprine remains to have suffered the least attrition of all. The meaning of these unexpected results is suff i-ciently uncertain to discourage their use in any attempt to correct for preservational bias in estimates of the relative importance as providers of meat of the various animals at Kissonerga.

Setting aside the problem of preservational bias, therefore, but combining the meat yield factors and recovery bias correction factors, produces a series of general correction factors for Kissonerga. These factors may be applied to the figures for the relative abundance of the main economic animals given in Tables 22.11b (Periods 3A and 3B), 11a (Period 4) and 10c (Period 5) to provide rough estimates of their relative importance in each period. The results of this exercise are pr e-sented in Table 22.14 and indicate that the relative abundance of caprines, by far the smallest of the three main animal taxa, would provide a greatly inflated i m-pression of their importance as suppliers of meat. For both deer and pig, and also for cattle in Period 5, the reverse is true to a much lesser degree. In round terms the estimates of relative importance in Table 22.14 suggest that between the M and LChal the proportion of meat provided by deer fell from two thirds to only a little more than one third. Pig increased in importance from providing about a quarter to providing just over half of meat consumed, whilst the contribution from caprines remained between one tenth and one twent i-eth. Put another way, at the beginning of the MChal deer may have provided well over twice as much meat as pig, whilst by the end of the Chalcolithic, about a millennium later, the contribution of pig to meat supply was considerably in excess of that of deer.

Assuming that at least the great majority of the Ki s-sonerga pigs and caprines were domestic stock whilst the deer were hunted, the estimates of relative abu n-

dance clearly signal a decline in the significance of hunting and an increase in the importance of herding during the M-LChal. In other words, a shift occurred towards greater labour-intensiveness in the exploitation of animals. The results of survey and excavation in western Cyprus suggest that settlements became i n-creasingly numerous as the Chalcolithic period pr o-gressed (Croft 1991, 72), and if this observation is i n-terpreted as indicating regional population increase, then a motive for the investment of greater effort by village communities in subsistence clearly exists.

Other evidence which independently corroborates the suggestion of economic intensification at Kisso n-erga during the Chalcolithic has already been outlined above and consists of the apparent tendency for deer to have been culled somewhat younger in the LChal (P e-riod 4) than in the preceding MChal (Period 3). The effect of such a change in emphasis upon the exploited population of deer would have been a reduction in a v-erage age, and thus an increase in biomass productivity. It is apparent, therefore, that efforts were made to i m-prove the efficiency of hunting even as its potential to function as the pre-eminent sector of the animal eco n-omy gradually declined in the face of the increasing subsistence requirements of an expanding human population.

During the Philia phase (Period 5) at Kissonerga, which succeeded the Chalcolithic, deer may have pr o-vided around half of the meat, pigs between a quarter and a third and cattle and caprines between a tenth and a twentieth (Table 22.14). The decline in the impo r-tance of hunting does not seem to have continued b e-yond the Chalcolithic, and indeed the meat yield est i-mates indicate the possibility (albeit very uncertainly due to the low reliability of the Period 5 sample) that its significance for subsistence underwent a resurgence during the Philia phase. This might correspond with lower levels of population following the end of the Chalcolithic. Be this as it may, it seems clear that the contributions to subsistence of deer hunting and cattle

herding were sufficient in the Philia phase to permit a reduction (perhaps by almost a half) in the very heavy dependence on swineherding which had gradually d e-veloped through the M and LChal.

That deer persisted as a subsistence resource of co n-siderable significance in the western Ktima Lowlands area for at least a further millennium after the occup a-tion of Kissonerga is indicated by the animal bones from the nearby Late Bronze Age site of Maa-Paleokastro (Croft 1988b). Between the later-third and later-second millennium BC it appears that the impo r-tance of cattle and caprines in the local animal eco n-omy grew and that of pigs declined still further.

Acknowledgements

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