DARK-AGE FAUNA FROM KAVOUSI, CRETE

THE VERTEBRATES FROM THE 1987 AND 1988 EXCAVATIONS

DURING THE SUMMERS of 1987 and 1988 excavations were conducted at Vronda and Kastro in the Siteia Mountains of East Crete.[1] Both sites are within five kilometers of the Bay of Mirabello; Vronda is *ca.* 425 m. above sea level at mid-slope, while Kastro is on a mountain peak at *ca.* 700 m. Midden debris recovered from Vronda was primarily Late Minoan IIIC, while that from Kastro was predominantly Late Geometric.[2]

Animal bones were included among the materials recovered from both sites. Although deposits were hand sorted and selectively dry screened and water screened, only the vertebrate fauna recovered by hand sorting and dry screening are reported here. Water-screened samples have not yet been completely processed and will be reported at a later time. Our objectives here are to provide a preliminary description of the kinds of animal remains that are being recovered from Vronda and Kastro, as well as to describe the condition of the two faunal assemblages.

Comparative skeletons of goat, sheep, cow, donkey, dog, cat, chicken, and several wild species native to Crete were loaned to the Kavousi project by the University of Tennessee, Department of Anthropology, to facilitate a preliminary assessment of the faunal remains. A large majority of the potentially identifiable bones recovered during 1987 and 1988 were identified with the aid of this relatively small comparative collection. Nonetheless, elements from several wild taxa were necessarily transported to the University of Tennessee for identification,[3] and some identifications were verified only after comparative skeletons had been collected on Crete between 1988 and 1990.

Vertebrate Taxa from Kavousi

Over 7,620 nonhuman animal bones were uncovered from Vronda, and roughly 9,990 were found at Kastro during 1987 and 1988 (Table). A greater proportion of the remains from Kastro (28 percent) were identifiable, primarily because of the excellent bone preservation at that site. Poor bone preservation at Vronda (only 16 percent identified) has resulted in increased fragmentation and erosion of critical, diagnostic features.

[1] Excavations at Kavousi were conducted by the University of Tennessee (Professor Geraldine C. Gesell, co-director), the University of Minnesota, and Wabash College (Professor Leslie P. Day, co-director), under the auspices of the American School of Classical Studies at Athens (Professor William D. E. Coulson, Director; excavation co-director). Financial support for the faunal analyses was provided by the Institute for Aegean Prehistory, the National Endowment for the Humanities, and the National Geographic Society. Walter E. Klippel also received generous support from the University of Tennessee, Department of Anthropology; the Liberal Arts College Research Incentive Fund; and the Professional Development Awards Program. A version of this paper was delivered at the sixth conference of the International Council for Archaeozoology (May 21–25, 1990), Washington, D.C.

[2] For a more extensive description of contexts see "Excavations at Kavousi, Crete, 1987," *Hesperia* 57, 1988, pp. 279–301 and "Excavations at Kavousi, Crete, 1988," *Hesperia* 60, 1991, pp. 145–177 above.

[3] Dr. Paul W. Parmalee, University of Tennessee, Knoxville, graciously identified the Kavousi bird bones.

TABLE: Identified faunal remains from the 1987 and 1988 excavations at the Vronda and Kastro sites, East Crete

Taxon (common name)	Vronda No.	Vronda %	Kastro No.	Kastro %	Total
DOMESTIC ANIMALS					
Caprine (sheep/goat)	838	70.0	2164	77.9	3002
Sus scrofa (pig)	190	15.9	246	8.8	436
Bos taurus (cattle)	59	5.0	230	8.2	289
Canis familiaris (dog)	31	2.6	66	2.4	97
Equus sp. (horse, donkey, mule)	12	1.0	2	0.1	14
Felis domesticus (cat)	0		1	<0.1	1
NATIVE ANIMALS					
Lepus capensis (brown hare)	57	4.8	36	1.3	93
Capra aegagrus (agrimi)	2	0.2	3	0.1	5
Dama dama (fallow deer)	0		12	0.4	12
Cervidae (deer)	0		2	0.1	2
Meles meles (badger)	2	0.2	4	0.1	6
Rattus rattus (black rat)	2	0.2	0		2
Columbia sp. (pigeon/dove)	0		1	<0.1	1
Alectoris/Perdix (chukar/partridge)	0		1	<0.1	1
Buteo sp. (hawk)	0		1	<0.1	1
Asio sp. (long-eared/short-eared owl)	0		2	0.1	2
Aves (birds)	4	0.3	5	0.2	9
Pisces (fish)	0		2	0.1	2
TOTAL IDENTIFIED	1197		2778		3975
UNIDENTIFIED	6425		7216		13641
TOTAL SPECIMENS	7622		9994		17616

Over 95 percent of the identifiable bones from both sites were those of domestic animals. Caprine (sheep and goat) remains were by far the most common, and of the bones that could be credibly differentiated,[4] sheep far outnumbered goats at both Vronda (26 sheep elements, 9 goat elements) and Kastro (89 sheep elements, 39 goat elements). Caprine bones were followed in relative abundance by pigs, cattle, dogs, equids (donkey, mule, or horse), and cat, respectively. Remains of native animals occurred in relatively low frequencies in both assemblages, with the bones of the brown hare occurring in greatest abundance (Table).

Cut and chop marks on agrimi (wild goat), badger, brown hare, cattle, dog, fallow deer, goat, pig, and sheep bones indicate that these animals had been butchered. Butchering marks occurred in greater numbers in the assemblage from Kastro. This apparent difference in butchering intensity or carcass utilization is, in reality, more likely due to the generally poor preservation of faunal materials at Vronda. Severe surface erosion and rounding of broken margins have undoubtedly obscured or obliterated many cut marks or chopped margins on the bones from Vronda.

While generally similar in the types of domestic species represented, the two assemblages differ significantly in some ways. Remains of caprines and dogs, for example, are nearly randomly distributed at the two sites. Caprine remains that we have identified to species (i.e., sheep *vs.* goat) indicate that nearly equal proportions of these animals also occurred at both sites. There are significant differences, however, in the occurrence of cattle and pig remains.

The greater representation of cattle at Kastro was somewhat surprising in that we initially assumed that the area around the lower, mid-slope village of Vronda, which today is surrounded by fruit and nut trees, grape vines, and grassy terraces, would have been better suited for grazing animals such as cattle and sheep. The higher area surrounding Kastro presently supports very little vegetation that would sustain any appreciable grazing, especially during the dry summer months. If bovids (cattle, sheep, and goats) were kept in and around the village of Kastro, and local environmental conditions during the Late Geometric times were similar to those of today, a relatively greater representation of browsers (i.e., goats) might have been expected in the faunal assemblage from Kastro.

Bone Modification

A large proportion of the bones from medium and large-sized mammals (i.e., dogs, agrimi, deer, sheep, goats, cattle, and pigs) from Kavousi appear to have been extensively

[4] A fair number of caprine bones have been purported to exhibit features that permit making distinctions between domestic sheep and goats (see, for example, J. Boessneck, H. H. Muller, and T. M. Teichert, "Osteologische unterscheidungsmerkmale zwischen schaf (*Ovis aries* Linne) und ziege (*Capra hircus* Linne)," *Kuhn-Archiv* 78, 1964, pp. 1–129; S. Payne, "Morphological Distinctions between the Mandibular Teeth of Young Sheep, *Ovis*, and Goats, *Capra*," *JAS* 12, 1985, pp. 139–147; W. Prummel and H. J. Frisch, "A Guide for the Distinction of Species, Sex and Body Side in Bones of Sheep and Goat," *JAS* 13, 1986, pp. 567–577. Of over twenty-five comparative sheep and goat skeletons that we have collected from Crete and Eastern North America, however, we have found the following elements to be the least problematic: first deciduous incisor, lower fourth deciduous premolar, horn core, parietal/frontal suture, distal humerus, proximal radius, proximal femur, astragalus, calcaneum, distal metapodial, and distal second phalange. Our distinctions were conservatively based on these eleven elements.

modified by the Dark Age inhabitants of Vronda and Kastro. Because nearly all the bones recovered from Vronda are badly eroded, generally masking the exact causes of their altered condition, we are restricting our comments here to the better preserved, Late Geometric assemblage from Kastro.

Long-bone diaphyses (shafts) of very young sheep, goats, and pigs from Kastro show cut marks indicative of disarticulation and defleshing, but a very high proportion of these fragile elements are otherwise intact. This contrasts markedly with long bones of more mature animals that are also cut and chopped but in addition are extensively fragmented. Numerous spiral fractures on mature specimens indicate that much of the fragmentation occurred while the bone was still fresh and not as the result of post-depositional taphonomic processes. Such "green bone" modification of adult long bones is usually attributed to carnivore feeding activities or human modification during the process of bone-marrow extraction.[5]

The fat in marrow cavities of mammal long bones is frequently sought by carnivores and sometimes by humans. Fat content varies, however, from one skeletal element to the next. In mature, healthy ungulates fat is generally most plentiful in the tibia, with progressively lesser quantities occurring in the femur, metatarsal, humerus, radio-cubitus, metacarpal, mandible, pelvis, scapula, first phalange, and second phalange.[6] Wildlife biologists have also shown that marrow fat varies with the age and nutritional condition of the animal. Bones of very young animals contain far less marrow fat than those of adults, and nutritionally stressed animals have significantly less marrow fat than well-nourished animals.[7]

Modern studies of carnivore modification of bone have shown that when carnivores crush complete ungulate long bones during feeding, a relatively high proportion (>70 percent) of the resultant long-bone shaft fragments exhibit gnaw marks.[8] Conversely, when such long bones are first smashed by humans, the marrow removed, and the smashed fragments then exposed to scavenging carnivores, a very low percentage (<10 percent) of the shaft fragments show carnivore marks.[9]

[5] G. Haynes, "Frequencies of Spiral and Green-bone Fractures on Ungulate Limb Bones in Modern Surface Assemblages," *American Antiquity* 48, 1983, pp. 102–114; E. Johnson, "Current Developments in Bone Technology," *Advances in Archaeological Method and Theory* VIII, M. Schiffer, ed., New York 1985 (pp. 157–235), p. 191.

[6] K. Jones and D. Metcalfe, "Bare Bones Archaeology: Marrow Indices and Efficiency," *JAS* 15, 1988, pp. 415–423.

[7] R. Field, "Increased Animal Protein Production with Mechanical Deboners," *World Review of Animal Production* 12, 1976, pp. 61–73; A. Franzmann and P. Arneson, "Marrow Fat in Alaskan Moose Femurs in Relation to Mortality Factors," *Journal of Wildlife Management* 40, 1976, pp. 336–339; P. Ratcliffe, "Bone Marrow Fat as an Indicator of Condition in Roe Deer," *Acta Theriologica* 25, 1980, pp. 333–340.

[8] C. Marean, R. Blumenschine, and S. Capaldo, "Bone Choice, Modification, and Destruction by Spotted Hyenas," paper presented at the sixth conference of the international Council for Archaeozoology (May 21–25, 1990), Washington, D.C.; D. Morey and W. Klippel, "Canid Scavenging and Deer Bone Survivorship at an Archaic Period Site in Tennessee," paper presented at the 54th Annual Meeting of the Society for American Archaeology (April 5–9, 1989), Atlanta, Georgia (forthcoming, *Archaeozoologica*).

[9] R. Blumenschine, "An Experimental Model of the Timing of Hominid and Carnivore Influence on Archaeological Bone Assemblages," *JAS* 15, 1988, pp. 483–502.

The extensive smashing of mammal skeletons to extract marrow and bone grease is well documented among present hunter-gatherers.[10] There is also considerable archaeological evidence that prehistoric groups modified bone in the process of marrow extraction.[11] Simon Davis, however, has noted that, in the Levant, long bones of ungulates show little evidence of deliberate fragmentation after animals were domesticated, some 10,000 years ago.[12] Faunal materials from Mousterian to Epipalaeolithic sites in Israel, for example, are extensively fragmented, while Chalcolithic and later assemblages show little evidence of deliberate fragmentation. Davis suggests, "In a hunting economy, man was likely to exploit the animal carcass to the full. Domestication of ungulates, however, provided an assured source of animal protein, which ended the need to exploit the carcass fully: man could now afford to be wasteful."[13]

Fewer than ten percent of the long-bone shaft fragments from Kastro show carnivore gnaw marks. This does not correspond to the high frequencies usually found when carnivores are the primary agents of bone modification. The gnaw-mark frequencies noted at Kastro do, on the other hand, compare favorably with the low frequencies found when carnivores, for example domestic dogs, are allowed access to long bones subsequent to marrow extraction by humans. In addition, nearly all the marrow-bearing bones from mature and nearly mature animals at Kastro have been smashed. Without exception, all but the phalanges and an occasional metapodial recovered from the site are fragmented. Only those elements that contain very little fat (i.e., phalanges, metapodials, and long bones of very young animals) have been recovered intact. This is in stark contrast to Davis' observation that remains of domestic animals are seldom deliberately modified for marrow removal in the Levant of the eastern Mediterranean.

The relative percentages of observable canid and human modification on domestic animal remains from the Kastro site (e.g., low percentages of gnaw marks, high percentages of fragmentation) indicate that the inhabitants of the Kastro site were consistently processing the bones of these animals for marrow. Why such intense utilization of bone marrow was taking place at Kastro during the early Iron Age is as yet undetermined.

Caprine Age Structure

The approximate ages of sheep and goats at the time they were slaughtered can provide an indication of how flocks were being managed. While sheep and goats are generally kept

[10] L. Binford, *Nunamiut Ethnoarchaeology*, New York 1978; H. Bunn, "Comparative Analysis of Modern Bone Assemblages from a San Hunter-Gatherer Camp in the Kalahari Desert, Botswana, and from a Spotted Hyena Den Near Nairobi, Kenya," *BAR International Series* 163, 1983, pp. 143–148; J. O'Connell and B. Marshall, "Analysis of Kangaroo Body-part Transport Among the Alyawara of Central Australia," *JAS* 16, 1989, pp. 393–405.

[11] J. Speth, *Bison Kills and Bone Counts: Decision Making by Ancient Hunters*, Chicago 1983; N. Noe-Nygaard, "Butchering and Marrow Fracturing as a Taphonomic Factor in Archaeological Deposits," *Paleobiology* 3, 1977, pp. 218–237.

[12] S. Davis, *The Archaeology of Animals*, New Haven 1987, p. 150.

[13] *Ibid.*

for a variety of purposes, Sebastian Payne has generated models based on work in Turkey that suggest whether caprine flocks were being kept primarily for their meat, or if, on the other hand, secondary products such as milk or wool were of primary importance.[14]

There is documentary evidence that, at least during the late Bronze Age, wool production was very important in Crete;[15] we have already noted that caprine remains from Kavousi were dominated by sheep, thus opening the possibility that flock management may have been oriented primarily toward wool production at Kavousi.

The age structure of faunal assemblages can be assessed by noting rates of epiphyseal fusion on long bones or by recording patterns of tooth eruption and wear, or both. Payne has suggested that data based on teeth are more reliable because of the potential for differential preservation of long bones whose epiphyses have not yet fused versus those that are fused.[16] Because tooth eruption and wear patterns are based primarily on teeth in complete or nearly complete mandibles, however, and because nearly all the Kavousi caprine mandibles have been extensively fragmented in the process of bone-marrow extraction, we have necessarily constructed caprine survivorship profiles for Kastro based on epiphyseal fusion (again, poor bone preservation at Vronda precludes the possibility of including that assemblage at this time).

We have adopted the ages for time of epiphyseal fusion from Halstead and Jones[17] and have made observations on the proximal and distal femur, radius, and tibia, as well as on the distal humerus, metacarpal, and metatarsal. A total of 683 long-bone fragments were used in our assessment of caprine age structure at Kastro.[18] These data have been used to construct a survivorship profile. The results were then compared to similarly constructed profiles for specialized meat, wool, and milk production (Fig. 1).[19]

The Kastro profile most closely approximates the meat model, with relatively high levels of mortality occurring between one and three years of age. Greater survivorship during this time would conform to the age structure of a flock managed for wool production, while accelerated mortality prior to one year of age would be more characteristic of a specialized milk strategy where young animals were eliminated because of their competition for milk.

[14] S. Payne, "Kill-off Patterns in Sheep and Goats: the Mandibles from Asvan Kale," *AnatSt* 23, 1973, pp. 281–303.

[15] J. Killen, "The Wool Industry of Crete in the Late Bronze Age," *BSA* 59, 1964, pp. 1–15; D. Young, "Some Puzzles about Minoan Woolgathering," *Kadmos* 4, 1965, pp. 111–122.

[16] S. Payne, "Zoo-archaeology in Greece: A Reader's Guide," *Contributions to Aegean Archaeology: Studies in Honor of William A. McDonald*, N. Wilkie and W. Coulson, edd., Minneapolis 1985 (pp. 211–244), p. 230.

[17] P. Halstead and G. Jones, "Early Neolithic Economy in Thessaly—Some Evidence from Excavations at Prodromos," Ἀνθρωπολογικά 1, 1980, pp. 93–117.

[18] Twenty-two mandibles from Kastro contained sufficient numbers of teeth to permit an assessment of approximate age based on tooth eruption and wear. While this number is small, the age structure based on teeth in mandibles is very close to that calculated on the basis of epiphyseal fusion.

[19] Data based on epiphyseal fusion cannot be extended much beyond three years of age. The major differences in Payne's models for specialized meat, wool, and milk production, however, occur within the first three years. Figure 1 has been modified from profiles illustrated by P. Halstead, "Man and Other Animals in Late Greek Prehistory," *BSA* 82, 1987 (pp. 71–83), p. 79, fig. 3.

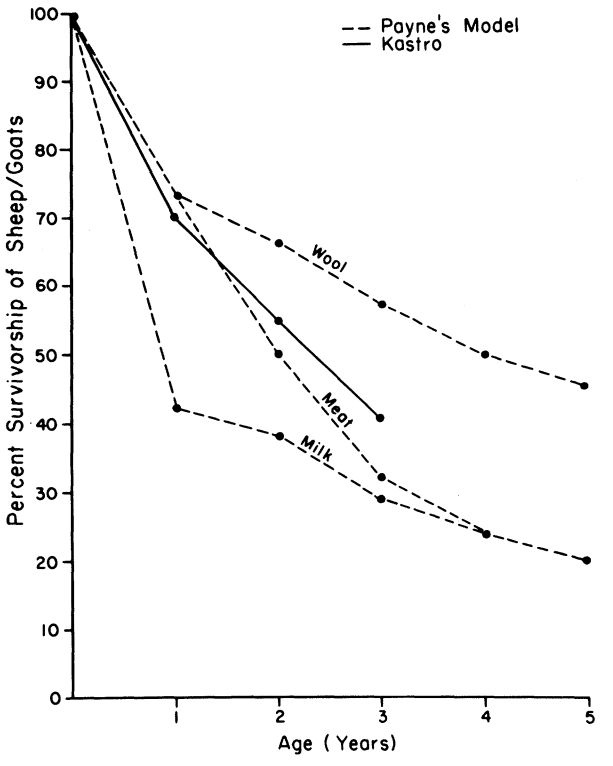

FIG. 1. The survivorship of Kastro caprines compared to Payne's models for specialized meat, milk, and wool production

This apparent optimization for meat does not imply that only meat was being exploited at Kastro. As noted above, sheep and goats may be kept for a variety of purposes.[20] In fact, Martin has pointed out that "... survivorship curves reflect specialized production only; there is no model for combined production."[21] Within the limits of Payne's model, then, the caprine age structure at Kastro does not suggest that flocks were being managed specifically for their secondary products as they may have been in earlier times when wool, for example, played an important role in the Late Bronze Age economy of Crete.[22]

SUMMARY OF PRELIMINARY ANALYSES

Considerable quantities of bone from the Kavousi Project have not yet been examined (i.e., material from 1989 and 1990 excavations and flotation samples), and further

[20] Halstead, *op. cit.*, p. 78; Payne (footnote 14 above).

[21] M. Martin, "Production Strategies, Herd Composition, and Offtake Rates: Reassessment of Archaeological Models," *MASCA Journal* 4, 1987, pp. 154–165.

[22] Killen (footnote 15 above).

identifications and analyses should place the Vronda assemblage on a more even footing with Kastro. A sufficient number of mandibles from Vronda, for example, should allow us to make generalizations about the caprine age structure and flock-management strategies from Vronda, even though bone preservation is poor and epiphyseal fusion cannot be used as a reliable indicator.

At this time less than half the bone recovered by the Kavousi Project has been identified and analyzed. Nevertheless, it is evident that the faunal assemblages from both sites hold considerable potential for better understanding Dark Age subsistence in East Crete. Our preliminary assessment of the Kavousi fauna indicates a heavy reliance on sheep, with goats, pigs, and cattle playing important but subsidiary roles in the subsistence economies at Vronda and Kastro. Caprines at Kastro appear to have been managed for meat production, and the extreme fragmentation of the bones of medium to large-sized mammals indicates that extraction of marrow from bones was also common.

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