This is a repository copy of *Animal carcass processing, cooking and consumption at Early Neolithic Revenia-Korinou, northern Greece* .

White Rose Research Online URL for this paper:
http://eprints.whiterose.ac.uk/133044/

Version: Accepted Version

Article:
Isaakidou, V., Halstead, P.L. orcid.org/0000-0002-3347-0637 and Adaktylou, F. (2018) Animal carcass processing, cooking and consumption at Early Neolithic Revenia-Korinou, northern Greece. Quaternary International, 496. pp. 108-126. ISSN 1040-6182

https://doi.org/10.1016/j.quaint.2018.05.040

Reuse
This article is distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND) licence. This licence only allows you to download this work and share it with others as long as you credit the authors, but you can't change the article in any way or use it commercially. More information and the full terms of the licence here: https://creativecommons.org/licenses/

Takedown
If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk/

Accepted Manuscript

Animal carcass processing, cooking and consumption at Early Neolithic Revenia-Korinou, northern Greece

Valasia Isaakidou, Paul Halstead, Foteini Adaktylou

PII: S1040-6182(17)31631-2

DOI: 10.1016/j.quaint.2018.05.040

Reference: JQI 7450

To appear in: *Quaternary International*

Received Date: 29 December 2017

Revised Date: 14 May 2018

Accepted Date: 27 May 2018

Please cite this article as: Isaakidou, V., Halstead, P., Adaktylou, F., Animal carcass processing, cooking and consumption at Early Neolithic Revenia-Korinou, northern Greece, *Quaternary International* (2018), doi: 10.1016/j.quaint.2018.05.040.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Animal carcass processing, cooking and consumption at Early Neolithic Revenia-Korinou, northern Greece

Valasia Isaakidou[1], *Paul Halstead*[2*] *and Foteini Adaktylou*[3]

[1] Institute of Archaeology, Oxford University, 36 Beaumont St., Oxford OX1 2PG, UK; val.isaakidou@gmail.com

[2] Department of Archaeology, University of Sheffield, Minalloy House, 10-16 Regent St, Sheffield S1 3NJ, UK; p.halstead@sheffield.ac.uk

[3] Eforia Arkhaiotiton Xalkidikis kai Agiou Orous, Ypourgeio Politismou kai Athlitismou, Polytexneiou 12, Polygyros 63100, Xalkidiki, Greece; adapap@otenet.gr

[*] corresponding author

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Key words

butchery; carcass processing; commensality; cooking; Early Neolithic; Greece

Abstract

The open-air settlement of Revenia-Korinou has yielded the largest Early Neolithic (7th millennium BC) faunal assemblage to date from Greece. The assemblage, recovered from numerous pits, is heavily dominated by domestic sheep, goats, pigs and cattle. Here we focus on the evidence for butchery and consumption of animals, to explore how carcass products were cooked (in the absence of cooking pots) and what if any role they played in commensal politics. Evidence for dismembering and filleting is sparse, implying butchery of domestic animal carcasses into large segments (including more or less complete limbs) for cooking, apparently in ovens or pits rather than on open fires. Subsequently limb bones were intensively smashed to extract marrow and probably grease, perhaps by boiling in organic containers. Dismembering, filleting and marrow extraction were most intensive for cattle, but bone grease was more systematically exploited in the case of sheep/goats, implying differences between taxa in contexts of consumption. Significant differences between pits in taxonomic composition and the incidence of gnawing and burning suggest that each represents short-term and/or localized discard, perhaps by a small residential group. Within individual pits, matching unfused diaphyses and epiphyses and joins between fragments broken in antiquity confirm rapid burial, but bones separated by dismembering seem to have been dispersed across the settlement before discard. The distribution of carcass products, both cooked and uncooked, played a role in shaping relationships between small residential units and the wider community at Early Neolithic Revenia-Korinou.

1. Introduction

The Early Neolithic (EN) settlements of Greece represent Europe's earliest (7th millennium BC – Maniatis, 2014) farming communities and the role of EN domestic animals in land use and commensal politics has been debated extensively (e.g. Halstead and Isaakidou, 2011a, 2013). Faunal assemblages of this period, however, have hitherto been small: the largest examples, from Achilleion, Argissa, Prodromos 1-2 and Sesklo in Thessaly, Agios Petros off the Thessalian coast, Franchthi Cave on the southern mainland, and Knossos on Crete (Figure 1), each comprise between about 800 and 2000 terrestrial vertebrate specimens identified to taxon (Halstead and Isaakidou, 2013, 32 table 7.2; Munro and Stiner, 2015, 597 table 1, Supplement A tables A1-A2). With roughly 400 specimens needed for a reliable estimate of site/phase species composition (cf. van der Veen and Fieller, 1982), these assemblages offer limited scope for analysis of husbandry and consumption patterns by taxon. The EN assemblage from Revenia-Korinou in Pieria, northern Greece, comprising about 10,000 identified terrestrial vertebrate specimens, is thus a very significant addition to available data and, for the first time, enables detailed and contextualised analysis of human exploitation of the earliest domestic animals in Europe. Here we postpone consideration of EN *live*stock management and landuse, to focus on evidence for consumption of *dead*stock and the role of animal carcasses in cuisine and commensal politics at Revenia-Korinou.

2. Revenia-Korinou in context

Revenia-Korinou lies in extensively cultivated lowlands, 30-40 m above sea level and 5 km from the current shoreline. The Neolithic site, first recognized from a 4-ha surface scatter of cockle shells (Besios and Adaktylou, 2006), is of 'flat-extended' type. Rescue excavation exposed 850 m^2, including more than 100 pits (of 0.5 to more than 5 m diameter and up to 1.68 m surviving depth), 71 postholes, three gulleys, a cobbled surface and a clay floor (Besios and Adaktylou, 2006; Adaktylou, 2017). The gullies, fragmentary surface and floor, and a few posthole groups imply above-ground structures in a phase of occupation later than the pits (Adaktylou, 2017, 141-153).

From the earlier phase, a few clusters of irregular, shallow hollows were probably created in extracting construction material, but several pits have vertical walls and an oval or rectangular outline. Of these, the larger examples, 4-24 m^2 in ground-level

surface area, were probably subterranean dwellings or basements, to which shallower contiguous pits provided access 'steps'. Postholes associated with some such pits perhaps supported a roof, while concentrations of daub (including burnt fragments) with organic impressions may be remains of superstructure (Besios and Adaktylou, 2006). Smaller pits, both within and apart from suspected dwelling pits, may have been cut as ancillary facilities (e.g. for storage). Fragments of hearth/oven in some pits, out of context but in concentrations unrelated to those of superstructural daub, may reflect functional differentiation between pits (Adaktylou, 2017, 140).

The eastern part of the excavated area yielded 65 pits in 400 m^2, the western part 17 pits in 175 m^2 and the intervening area only four pits and 22 postholes in 150 m^2. Although variable erosion may partly account for these differences, pits rich in animal bone are concentrated to the northeast of those rich in ceramics (Figure 2; Besios and Adaktylou, 2006; Adaktylou, 2017, plan 2), apparently independently of date, implying some collective structuring of space in the earlier phase of occupation. Conversely, the size of 'dwellings' suggests day-to-day residence in much smaller social groups, whether some form of family (most plausible for the largest pits) or just one to two individuals (perhaps more likely for the smaller 'dwelling' pits). Intra-site spatial organization in the earlier 'pit' phase at Revenia-Korinou may be typical, therefore, of Greek Neolithic settlements in promoting both collective and smaller-scale identity (e.g. Kotsakis, 1999, 2006; Pappa, 2008).

A significant role for commensality in negotiating these competing scales of solidarity has been inferred from a range of archaeological proxies for storage, preparation and consumption of food and drink (e.g. Pappa et al., 2004; Halstead, 2007; Isaakidou, 2007; Tomkins, 2007; Urem-Kotsou and Kotsakis, 2007; Halstead and Isaakidou, 2011a; Tzevelekidi, 2012; Kalogeropoulou, 2014; Lymperaki et al., 2016; Urem-Kotsou, 2017). More particularly, infrequent 'special' commensal events involving widespread distribution of meat arguably played a vital role in promoting collective solidarity without undermining an emerging principle of household control of stored staple grains (Halstead, 2004). Discussion has focused, however, on the later Neolithic, when more substantial 'domestic' architecture makes identification of 'households' less contentious and rich ceramic assemblages include unambiguous cooking vessels, for which there is no evidence at EN Revenia-Korinou (Urem-

Kotsou, in press). Against this background, we explore processing and consumption of animal carcasses, how these were cooked without pots, and whether they played a significant role in commensal politics at EN Revenia-Korinou.

3. Material and methods

Recovered by hand under rescue conditions, the faunal assemblage was studied using modern reference collections of the authors, the Department of Archaeology of the Aristotle University of Thessaloniki, and the Fitch Laboratory of the British School at Athens. Discrimination between fallow and red deer followed Lister (1996) and between sheep and goat Boessneck et al. (1964), Prummel and Frisch (1986), Kratochwil (1969), Payne (1985a), and Halstead et al. (2002). Age at death of domestic animals (not considered in detail) was estimated from mandibular cheek-tooth eruption/wear and limb-bone development. Limb bones were classified, on size, morphology and surface texture, as neonatal(/foetal) or older, while the latter were further differentiated, where possible, on the basis of epiphyseal fusion. Selected measurements, relevant here in distinguishing wild aurochs from domestic cattle and wild boar from domestic pigs, follow von den Driesch (1976). Bones were recorded as whole, 'new break' (broken in/since excavation; ignored if mendable), or 'old break'. 'Long bone' (humerus, radius, metacarpal, femur, tibia, metatarsal) and phalanx 1-2 specimens with old breaks were further classified as articular 'end', 'shaft' or 'end+shaft' and as 'splinter' or preserving, at least partly, the entire bone circumference, following Binford's (1981) observations on the contrasting results of carnivore attrition and human extraction of marrow/grease. 'Freshness' of break (Outram, 2002), time-consuming and potentially ambiguous with heavily fragmented material, was not recorded. Traces of canid- and rodent-type gnawing, digestion, burning and butchery were also recorded, with the last attributed, where possible, to skinning, dismembering, filleting, or marrow extraction following Binford (1981) and on the basis of anatomical placement.

Routine recording was restricted to the following relatively robust, identifiable, easily quantified and informative body parts: mandible (cheek-tooth row), scapula, pelvis, long bones (treating proximal and distal halves as distinct anatomical units), proximal ulna, astragalus, calcaneum, and phalanx 1-3. Notes were also taken on certain

specimens excluded from quantified taxonomic and anatomical analysis: horn/antler of relevant species; maxillary teeth of rare taxa; carapace segments of tortoise; carpals or tarsals bearing butchery marks or articulating with recorded specimens; and ribs and vertebrae bearing butchery marks (rare overall). Since even small fragments of selected body parts were recorded, total numbers of identified anatomical units ('MaxAU', counting *proximal and distal halves of long bones separately*) might *over*represent body parts, taxa, and age/sex categories prone to breaking into several durable and identifiable pieces. To counter this, estimated minimum numbers of anatomical units ('MinAU' – a variant of Binford's 'MNE' (Lyman, 1994a, 42)) are used to assess anatomical and taxonomic abundance. Breakage, gnawing, burning, and butchery are quantified using MaxAU, however, because MinAU discounts poorly preserved or heavily fragmented (and hence imprecisely identified) specimens and so underestimates the frequency of such modifications. Where two or more fragments might be derived from the same anatomical unit (e.g., a single left proximal tibia) of the same individual animal, only the most complete example contributes to MinAU. Similarly, to simplify comparison between species with different numbers of foot bones, metapodial and phalanx fragments are quantified in terms of minimum numbers of feet; for example, if two phalanx 2 specimens could be derived from the same foot of the same individual animal, only one contributes to MinAU. MinAU was assessed visually after strewing specimens into anatomical/taxonomic groups (e.g., pig humerus) and sub-groups (left/right, proximal/distal, medial/lateral, fused/unfused, etc.). Notional (and real) 'joins' between fragments were sought within but not between each context (pit, etc.). Because only 30% of sheep and goat specimens were identified to species, much of the following analysis treats these skeletally similar taxa together.

The assemblage, excluding excavation units dated on ceramic or stratigraphic grounds as later than EN (or conceivably initial MN – Urem-Kotsou et al., 2015), comprises 9,949 identified and recorded specimens (NISP) of body parts selected for systematic analysis, which represent (counting separately long-bone proximal and distal halves) 10,904 MaxAU and 9,557 MinAU. This material is derived from 78 contexts (Table 1), of which only 0.5% (from cobbled Floor 1 and Gulley 1) represents the suspected later phase of above-ground habitation. The remaining contexts are earlier pits. In addition to suspected entrance 'steps' or basements of dwellings, some overlapping or

nested features represent cutting of an earlier by a later pit. Faunal material from such intersecting pits (e.g. Pits 3, 3α and 3β) is here combined (Table 1) if they were largely filled (and/or excavated archaeologically) as single units.

Identified faunal material is very unevenly distributed, so only eight contexts, each comprising between 365 and 843 MinAU and together making up 46% of the assemblage, warrant separate analysis and only for some variables (Table 2; Figure 2). Of these contexts, five (Pits 18, 24, 42, 48, 51) were classified during excavation as bone-rich (*relative* to other finds and pit volume) and three (Pits 2, 7, 11) as ceramic-rich, while only Pit 18 (of irregular shape) was not tentatively identified as a pit-dwelling (Adaktylou, 2017, 148). Pit 11 also served, during or after infilling, for human burials.

In terms of the tripartite subdivision of the Early Neolithic proposed for nearby Paliambela-Kolindrou (Maniatis et al., 2015), available ^{14}C determinations date ten pit fills to ENI (6600-6400 BC), seven to ENII (6400-6200 BC), and one to ENII or ENIII (6200-6000). Relative chronology from pit intersections assigns 14 further fills to ENI, three to ENI or ENII, four to ENI or ENII or ENIII, and four to ENII or later (Table 1, after Adaktylou, 2017). In MinAU, 59% of the faunal assemblage (including seven of the eight faunally rich pits) is thus provisionally dateable to ENI and 75% (including all eight faunally rich pits) to ENI or ENII, leaving 25% of later (ENII-III or ENIII) or uncertain date within EN. Given the scarcity of later EN material and that stratigraphic analysis of ceramics is ongoing, no diachronic analysis will be attempted here.

4. Results

4.1 Taxonomic and demographic composition

The EN assemblage is heavily dominated by domesticates (98% of MinAU) with minor contributions, in descending order of abundance, from roe deer (*Capreolus capreolus*), fox (*Vulpes vulpes*), hare (*Lepus europaeus*), boar (*Sus scrofa*) and fallow deer (*Dama dama*), aurochs (*Bos primigenius*), red deer (*Cervus elaphus*), tortoise (*Testudo* sp.), hedgehog (*Erinaceus europaeus*), badger (*Meles meles*) and bear (*Ursus arctos*) (Table 1). Of the common domesticates (with *pro rata* re-assignment to sheep or goat of specimens identified only to sheep/goat), sheep (*Ovis aries* – 55%)

are most abundant, followed by goats (*Capra hircus* – 16%), pigs (*Sus domesticus* – 14%), cattle (*Bos taurus* – 13%) and dogs (*Canis familiaris* – 0.2%). In the eight faunally rich contexts, again wild animals (2%-4%) and dogs (<1%) are consistently scarce and sheep clearly most abundant (45%-63%), as usual for EN Greece (Halstead and Isaakidou, 2013), while goats (12%-26%), pigs (8%-20%), and cattle (3%-20%) are more variable in representation (Table 2).

Mortality patterns are not examined in detail here, but postcranial evidence of neonatal deaths is sparse (3.1% of cattle, 3.3% of pig and 2.4% of sheep/goat MinAU) and, thereafter, epiphyseal fusion and mandibular eruption/wear concur that pigs were slaughtered much younger than cattle or sheep/goats – again as usual for the earlier Greek Neolithic (e.g. Isaakidou, 2006).

4.2 Recovery losses

The assemblage includes numerous small fragments (e.g. sheep/goat phalanx splinters) and bones (e.g. neonatal sheep/goat and pig phalanges), suggesting unusually thorough hand-collection. Nonetheless, the relative abundance of anatomically adjacent large and small skeletal parts of taxa of different sizes (cf. Payne, 1985b) suggests that severe fragmentation (below) and rescue excavation have together caused loss of small specimens. While in complete feet the ratio of distal metapodials (metacarpals and metatarsals) to smaller first, second and third phalanges is 1:1:1:1 MinAU, incomplete retrieval (other things being equal) favours under-representation of phalanges, especially for smaller taxa. At Revenia-Korinou, phalanges are indeed heavily underrepresented and more so in pigs and especially sheep/goats than larger cattle (Table 3). An alternative interpretation, that phalanges of smaller taxa were left attached to skinned hides and discarded elsewhere, is contradicted by anatomical representation in the lower hind-limb: with full recovery, the expected ratio of distal tibia to adjacent astragalus, calcaneum and proximal metatarsal is again 1:1:1:1, but here the smaller astragalus and calcaneum are heavily underrepresented and more so in sheep/goats and pigs than cattle (Table 4). The following analyses must take account, therefore, of likely recovery loss of small specimens.

4.3 Post-depositional and post-discard losses

The recovered animal bone is overwhelmingly robust, with no indication of significant degradation during burial. Encrustation has not obscured surface traces (e.g. of gnawing, butchery) and heavy weathering or erosion was observed on only 0.1% of the assemblage (MaxAU, excluding very durable loose teeth and very fragile neonatal specimens). Domestic dogs are represented, however, and 11.4% of the assemblage bears traces of gnawing by dogs (or possibly foxes, pigs or even humans – cf. Stallibrass, 1984; Greenfield, 1988; Saladié et al., 2013) and a further 1.0% of ingestion (followed by excretion on site, so probably by domestic dogs or pigs rather than wild foxes). In addition, 0.2% have signs of gnawing by small rodents, for example on areas of ligament attachment of an otherwise complete first phalanx of sheep and another of roe deer in Pit 18.

The combined incidence of gnawing and ingestion of limb bones varies highly significantly between the three principal domestic taxa, from 11.0% in sheep/goats and 13.6% in cattle to 19.8% in pigs (Table 5), implying that pig bones were most accessible or attractive to scavengers. Gnawing/ingestion also differs highly significantly between the eight faunally rich contexts, from 5.3% in Pit 51 to 22.3% in Pit 24, but partly because of variation in the frequency of the three principal domestic taxa and, in six of the eight pits, pigs again exhibit most gnawing/ingestion. Nonetheless, variation between these pits in gnawing/ingestion is highly significant for pigs and sheep/goats (Table 6), implying contextual differences in the volume of discard, speed of burial, or method of cooking, and hence attractiveness to scavengers (cf. Speth, 2000), of bones.

Compared with modern goat bones subjected to trampling and both canid and human gnawing (Brain, 1981, 22 fig. 17), and ignoring phalanges, astragalus and calcaneum perhaps lost during excavation, anatomical representation is relatively even for Revenia-Korinou sheep/goats and also pigs and cattle (Figure 3). Similarly, the MinAU ratios of distal to proximal humerus, perhaps the most and least robust parts respectively of the appendicular skeleton, are much more even (cattle 1:0.8, pigs 1:0.6, and sheep/goats 1:0.8), implying far less attrition, than at nearby Late Neolithic (LN) Makriyalos I (1:0.3, 1:0.5, and 1:0.5, respectively – Tzevelekidi et al., 2014, 428-29, figs. 2-4).

Despite modest attrition, the assemblage is heavily fragmented (Figure 4), with mainly smooth breaks suggesting breakage in 'fresh' state (cf. Outram, 2002). Excluding fragile neonatal material and fragments with new breaks inflicted during/since excavation, complete specimens make up only 0.3% of cattle, 0.9% of pig and 0.1% of sheep/goat long bones (difference between taxa highly significant – Table 7a). Among remaining old-break fragments, however, shaft 'cylinders' such as canids commonly create are far scarcer than articular ends and end-splinters typical of deliberate anthropogenic breakage (Table 7b, excluding ambiguous shaft splinters): 2.5% cylinders for cattle, 13.7% for pigs, and 8.3% for sheep/goats (difference between taxa again highly significant). Long bone *shafts* of cattle, the largest and most robust species, are most fragmented and those of pigs, with the highest proportion of fragile young bones and highest incidence of gnawing, least so, confirming deliberate human action rather than trampling or scavenger attrition as the main cause of breakage. Indeed, the apparently modest impact of domestic dogs on bone survival at Revenia-Korinou may be attributed to intensive anthropogenic extraction beforehand of within-bone nutrients (cf. Yellen, 1991, 186).

4.4 Discard

In a few 'dwelling pits', a basal occupation layer was more or less securely identifiable (Adaktylou, 2017, 146-147). C14 samples (except for human burials) were taken where possible from the lowest part of each pit (Adaktylou, 2017, 116-117), but most faunal material is derived from fills post-dating any original use for habitation, storage or clay extraction (Adaktylou, 2017, 122, 192-194). Moreover, bedrock lumps in some fills, probably fallen from pit walls (Adaktylou, 2017, 44, 47, 52, 54, 57, 60, 69, 72, 74-75), suggest exposure to weathering after the removal or collapse of any protective roofing. The rarity of weathered or heavily abraded bone (above), however, implies filling of pits with material exposed only briefly on the surface. Moreover, highly significant differences in frequency of gnawing between the eight faunally rich pits (above) further suggest that each fill represents relatively short-lived or spatially localised bone discard rather than reworking of long-term or widespread refuse. Ceramic abrasion in Pits 7 and 11 similarly indicates material that, overwhelmingly, had not undergone prolonged surface exposure before burial (Papaioannou, 2010, 119).

Fairly rapid burial is also suggested by frequent 'joins' between bone specimens within pits (Table 8). Of these, 144 limb-bone specimens represent 72 matches between unfused epiphysis and diaphysis (or unfused acetabular components), while 98 specimens (including a few carpals and tarsals excluded from tabulated MaxAU and MinAU totals) articulate with one or more anatomically adjacent bones snugly enough to be from the same limb or mandibular pair of the same individual animal (Figure 5). Such joining specimens (excluding *fused* goat proximal radius and ulna or pig mandibular pair) were far more likely to end up in the same pit if buried soon after discard, while connected by soft tissue – as was unambiguously the case for an articulating left distal humerus, proximal radius and proximal ulna of cattle from Pit 5β, cemented by sediment in correct anatomical position (Figure 6). Joins were also found between 99 fragments broken in antiquity: some were perhaps initially connected by soft tissue, but others were separated before discard (e.g. two sheep/goat femurs, from Pits 7 and 26, each represented by adjoining fragments of contrasting surface colour). Finally, two apparent pairs, of cattle distal tibia and distal metatarsal, were buried together before scavenging or trampling could scatter the matching left- and right-sided specimens. Joins were not sought *between* pits, for practical reasons, but were identified *within* 30 pits, including all eight faunally rich contexts. Although additional cases were doubtless overlooked in such fragmented material, the surprisingly high number of observed joins implies that much of the assemblage was buried before connecting soft tissue decayed and, occasionally, before unconnected specimens from the same carcass were dispersed across the site. Analysis of ceramics in Pits 7, 11, 26 and 34 similarly identified joining fragments that imply burial of some material fairly soon after initial discard (Papaioannou, 2010, 119; Silva García, 2011, 59-60).

4.5 Carcass processing, cooking and consumption

4.5.1 Carcass dressing: the evidence of anatomical representation

Some variability in anatomical representation of cattle, pigs and sheep/goats at Revenia-Korinou (Figure 3) is attributable to partial survival or retrieval. Mandibles of all three taxa are notably less numerous (MinAU), however, than several meat-rich limb units: proximal and distal humerus, proximal radius, distal femur, and proximal and distal tibia (and also meat-poor proximal and distal metatarsal) of cattle; distal humerus, proximal and distal femur, and proximal tibia of pigs; and distal humerus

and proximal radius (and also meat-poor proximal metatarsal) of sheep/goats. Teeth are more robust than bones and ageable teeth less likely than most bone fragments to be discounted in estimating MinAU, so mandibles were arguably removed, probably with the rest of the head during initial carcass dressing, and either discarded away from the excavated area or displayed (and exposed to weathering) while the rest of the skeleton was buried.

There is no compelling evidence that foot bones were also removed (with or without the hide) during initial butchery: sheep/goat and pig phalanges may be underrepresented because of un-sieved recovery, coupled with intensive fragmentation (above, 4.2), and pig metapodials because, when splintered, they are far less identifiable than those of sheep/goats and cattle. The abundance of meat-rich long bones, mostly late-fusing and relatively fragile, might alternatively be attributed to the lower limbs, especially of cattle and pigs, being discarded off-site. For example, the proximal tibia is *much better* represented than its leaner and more robust distal counterpart in cattle (by 40%) and pigs (by 49%), and slightly so in sheep/goats (by 4%), inviting speculation that lower hind limbs were often removed from the carcass by chopping through the tibia shaft. Other evidence, however, suggests that these distal parts were discarded neither off-site nor during initial carcass dressing (below, 4.5.2).

4.5.2 Butchery: the evidence of chop and knife marks

Butchery marks, observed on 2.9% of recorded specimens (excluding weathered/eroded fragments and loose teeth), are fewer (using the same methodology) than for north Greek LN Toumba Kremastis-Koiladas (4.1% - Tzevelekidi, 2012, 51 table 4.6), LN Makriyalos I (4.1%), and FN Doliana (6.4%) (Halstead, 2007, 37 table 3.2), but perhaps due to greater fragmentation (and thus more uncut specimens) at Revenia-Korinou rather than less intensive butchery. Most butchered specimens (2.8%) bore ‘knife marks’ suggestive of chipped stone, but a few had chop marks (0.2%), where a heavy tool (presumably a stone celt or ‘axe’) had bitten (cf. Helmer and Courtin, 1991) into the bone (Table 9). While some of the latter were inflicted deliberately in fracturing or chopping through bone, knife-marks were probably inflicted inadvertently in severing soft tissue (because contact with bone dulls or damages the cutting edge and may contaminate meat with tiny, sharp stone chips –

e.g. Chan et al., 2010). Experiments suggest that knives usually cut bone when forcefully severing raw rather than cooked flesh.

Both knife and axe marks are sparse and widespread through the assemblage (in 41 and 14 of 78 depositional contexts, respectively), but their frequency varies significantly between taxa. Among the principal domesticates, long-bone shafts are most intensively fragmented in cattle and least so in pigs, while long-bone articulations are more intensively broken in sheep/goats than cattle or pigs (below, 4.5.4), so specimens with cut marks – other things being equal – should be most frequent in pigs. Both knife and chop marks are highly significantly more frequent in cattle (6.9% and 0.9%, respectively), however, than pigs (4.0% and 0.0%) or sheep/goats (1.8% and 0.0%). The larger carcasses of cattle were butchered more intensively, therefore, with greater use of heavy chopping tools, than those of sheep/goats and pigs. Among the rarer taxa, butchery traces are absent or restricted to single examples in dog, red deer, fallow deer, roe deer, fox, badger, bear, hare, hedgehog and tortoise. Seven of only 21 aurochs and three of only 27 boar specimens bore cut-marks, however, so these large game taxa were apparently butchered even more intensively than cattle.

Knife marks were attributed, according to anatomical placement (cf. Binford, 1981), to three principal stages of soft-tissue butchery, skinning, dismembering or filleting (summarized in Figures 7-9, including cut body parts not routinely recorded). Quantification requires caution, given variable anatomical representation and fragmentation (Domínguez-Rodrigo and Yravedra, 2009), but the three principal domestic taxa differ in *how* their carcasses were butchered. First, both dismembering and filleting knife marks are almost as common in cattle (72 and 27, respectively – Figure 7) as in the much larger sample of sheep and goats (85 and 31 – Figure 8), implying that preparation for consumption involved subdividing the large carcasses of the former more intensively and stripping their bones of raw meat more frequently. Secondly, although less fragmented long-bone shafts have probably enhanced the apparent frequency of filleting in pigs (Figure 9), the near parity of dismembering (26) and filleting (21) traces suggests more intensive subdivision of their carcasses and, especially, more frequently stripping of their meat from the bone than in sheep and goats.

Differences between taxa are also evident in the anatomical distribution of butchery (Figures 7-9). Cuts to four cattle calcanea perhaps freed the Achilles tendon to suspend carcasses by a rope through the hock (Binford, 1981, 119-120, fig. 4.27 b-c), presumably from a mature tree given their weight, to facilitate skinning and dressing. Skinning marks, necessarily restricted to the extremities, are relatively scarce, recorded around the head on one cattle mandible and around the feet variously on the metacarpal (cattle, pig, sheep and sheep/goat), metatarsal (cattle, sheep and sheep/goat), first phalanx (pig and goat), or second phalanx (cattle and goat). 'Dismembering' cuts around the foot and 'ankle' might also have initiated removal of the hide, however, cautioning against inferring differences between taxa in skinning procedure.

Dismembering was observed in cattle at all the major limb joints: in the forelimb at the shoulder (scapula/proximal humerus), 'elbow' (distal humerus/proximal ulna/proximal radius), 'wrist' (distal radius/carpals/proximal metacarpal) and mid-foot (distal metacarpal/phalanx 1); and in the hind limb at the hip (pelvis/proximal femur), 'knee' (distal femur/proximal tibia), 'ankle' (distal tibia/tarsals/proximal metatarsal) and mid-foot (distal metatarsal/phalanx 1). Marks were most frequent at the ankle and secondarily the elbow, consistent with the difficulty of dismembering these joints and probability of cutting bone in the process. In pigs, dismembering traces are lacking at the shoulder and wrist, but again most frequent at the ankle and then elbow. For sheep/goats, dismembering is not documented at the wrist, but is most frequent at the hip, followed by the ankle. Dismembering around the robust elbow joint, normally well represented, is slightly less frequent than around the shoulder, suggesting preparation for consumption of many sheep/goat forelimbs as a single unit; a single dismembering mark at the knee (compared with five among far fewer cattle specimens) implies the same for the hind limb. Six of seven cut aurochs specimens (one chop- and five knife-marks) and two of three cut boar bones indicate dismembering of the elbow, suggesting particularly frequent sectioning of the forelimb of these large game animals – perhaps to facilitate transport from more or less distant kill-sites.

Filleting is evident on the mandible and all major meat-rich limb bones of cattle and

pigs, and also on one cervical and one lumbar vertebra of cattle, one lumbar vertebra of sheep/goat, and one cattle- and one sheep/goat-sized rib, but not on the numerous mandibles and scapulae of sheep and goats. 'Filleting' knife-marks on a few fragmented metacarpal and metatarsal shafts of cattle, (sheep/)goat and roe deer may reflect removal of the periosteum before marrow-cracking (cf. Binford, 1981, 134) and one such bovine metatarsal bore signs of a blow that broke open the shaft.

Carcasses were skinned and dismembered mostly with chipped-stone knives, but sometimes with heavier tools. In cattle, a chop through a mandible diastema removed the chin to expedite skinning (or separated left from right mandible), one to the hinge dismembered a second mandible from the cranium, chops to an astragalus and calcaneum perhaps dismembered the ankle, and a chopped lumbar vertebra and cattle-sized rib may reflect portioning for cooking or consumption. Chops to the base of two goat horns may have removed the horn to facilitate skinning, while the anterior crest of a sheep/goat tibia had been chopped off (with the knee flexed) from the proximal articulation, perhaps in removing the patella to facilitate dismembering. A sheep and an indeterminate sheep/goat had been disarticulated at the hip by chopping the proximal femur ball joint and articulating acetabulum from the rest of the femur. The sheep/goat ball joint subsequently passed through the gut, presumably of a dog, and a few further, ingested proximal femur ball joints of sheep/goat perhaps had similar butchery histories of which no trace has survived. No evidence was observed for skinning or dismembering pigs with axes. An aurochs ulna, however, found with (not fused to) its matching proximal radius, had been chopped through longitudinally in a medio-lateral plane, presumably during dismemberment from the (missing) distal humerus.

Sparse chop-marks through bone shafts of cattle (humerus, radius, metacarpal, pelvis, femur, tibia, phalanx 1), pigs (mandible, tibia) and sheep/goats (pelvis) might reflect sectioning of some (especially cattle) carcasses with axes rather than knives. A few groups of articulating cattle bones at first sight resemble products of such butchery. The cemented elbow joint, discussed above, from Pit 5β exhibits a chop through the humerus shaft, but also a blunter percussion scar on the radius that enabled removal of an anterior shaft splinter, exposing the marrow cavity (Figure 6). Pit 24 yielded articulating sections of three lower forelimbs (one right fused and two left unfused

distal radii with adjacent carpals) and one lower hindlimb (unfused distal tibia with adjoining tarsals and proximal metatarsal), but none bore signs of sectioning with an axe. Conversely, transverse knife-cuts across a carpal had dismembered one lower forelimb from the foot and, in the hindlimb, a knife-cut and heavy blow had (as described above) prepared and then broken the metatarsal shaft for marrow extraction. The few bones chopped mid-shaft and few articulating limb segments may result, therefore, not from sectioning carcasses for cooking, but from fracturing bare bones for marrow extraction. This fourth stage of butchery left few clear chop-marks, suggesting expedient recourse to passive anvils (Blasco et al., 2014), axe butts or other heavy objects (e.g. an aurochs metacarpal from Pit 11, with proximal end apparently used as pounder/bludgeon) and favouring breakage of bones mainly stripped of meat rather than cushioned by uncooked flesh. Analysis of burning traces and fragmentation patterns sheds further light on this.

4.5.3 Cooking: the evidence of burnt bones

While cooking 'on the bone' may expose bone or tooth protruding from protective flesh to fire or heat, resulting in localized alteration, wholesale burning of skeletal material probably – barring accidents – reflects discard activity. Overall, 5.3% of the assemblage (including loose teeth, but treating lightly 'scorched' specimens (cf. Lyman, 1994b, 385) as unburnt – see below) is wholly or partly burnt (Table 10). This figure varies strikingly and highly significantly between the eight faunally rich pits (Table 11), from 2.8% in Pit 48 to 15.0% in Pit 2, but modestly between the principal domesticates, from 4.8% in sheep/goats to 6.4% in pigs and 6.8% in cattle. Contextual differences thus probably reflect discard rather than culinary history and, regardless, again favour a short-lived or spatially localized source for each pit fill. Frequent burning in fox (16.2%), hare (11.1%) and badger (100.0%, but of only two specimens) conceivably indicates distinctive methods of cooking for small game.

Because different body parts are more or less susceptible to destruction by fire, variation in incidence of burning is further examined between the three principal domestic taxa *within each body part* (Table 12). Significant variation between taxa occurs only in mandible and astragalus (more frequent burning in cattle and pigs than sheep/goats) and in proximal metacarpal, distal metatarsal and phalanx 1 (more burning in cattle than smaller domesticates). Frequent burning of astragali in cattle

(23.5%) and pigs (20.0%; cf. sheep/goats 3.3%) is intriguing because several astragali were found with matching calcaneum, burning of which is relatively infrequent (cattle 6.7%, pigs 11.8%, sheep/goats 3.2%). Apparently, astragalus and calcaneum were sometimes deliberately separated, perhaps to use the former for gaming or divination or conceivably to exploit the Achilles tendon attached to the latter (cf. Vainshtein, 1980, 212). Reasons for selective burning of other body parts are explored below.

Localized burning compatible with cooking on the bone is most common in mandibles of pigs, with burnt canine tips or cheek-tooth crowns (8 cases each), but also in burnt cheek-tooth crowns of sheep, cattle and badger (one case each). Just the heads (or mandibles) of pigs were roasted or baked, since similar traces on their lower limbs or feet are lacking, but a complete hare metacarpal with burnt distal articulation might reflect roasting of the whole animal. Conversely, burning of both ends of a sheep pelvis and fox tibia shaft suggest 'barbecuing' of small cuts of meat, while a second sheep pelvis with scorched acetabulum only also implies cooking on the bone, following dismembering of the hip (above, 4.5.2).

Numerous marrow-bearing elements (mandible, long bones, phalanx 1-2) display localized burning or scorching around an impact scar, suggesting heating of bone shafts to facilitate marrow extraction. Excluding whole bones, unfused epiphyses and neonatal specimens, the combination of burning/scorching and breakage is much commoner in cattle (9 burnt + 17 scorched/929 = 2.8%) than sheep/goats (24 + 14/6095 = 0.6%) or pigs (3 + 2/1045 = 0.5%), paralleling more intensive fragmentation of long-bone shafts in the largest domesticate. Frequent burning of cattle metapodials, first phalanges and perhaps mandibles is thus parsimoniously attributable to direct contact with fire in preparation for marrow extraction, while other long bones were perhaps usually heated during cooking, covered with meat, in an oven or pit (e.g. Kent, 1993, 341-343; Thoms, 2008).

4.5.4 Cooking: the evidence of bone fragmentation

The diaphyses of four first (two cattle, one pig, one sheep/goat) and two second (cattle) phalanges exhibit piercing of the anterior, posterior or medial face, presumably for marrow. The holes, apparently chipped rather than drilled or cut or punched, resemble far more numerous examples, almost exclusively on cattle first

phalanges, at Neolithic Knossos on Crete (Isaakidou, 2004, 202-3). The more usual method of extracting marrow at Revenia-Korinou, however, was to fragment rather than pierce long bones and phalanges 1-2, often after preparatory heating – whether to remove the enveloping periosteum, render the bone more brittle, or liquefy the contents.

As noted above, long-bone shafts were most intensively fragmented in cattle and least so in (mostly young) pigs, the reverse of expectations based on skeletal robusticity, but compatible with human selection for quantity and quality of marrow, respectively. Conversely, fragmentation (presumably for bone grease) of long-bone articulations (Table 7c) is highly significantly more frequent in sheep/goats (85% broken) than cattle (69%) or pigs (75%). Likewise, fragmentation of phalanges 1-2 (Table 7d; Figure 10) is highly significantly more intensive in sheep/goats (ca. 80%) than cattle or pigs (ca. 50-60%) and, since broken phalanges of the smaller domesticates are particularly susceptible to recovery losses, these figures surely understate the difference between sheep/goats and cattle. These results are unexpected, because larger articulations and phalanges yield more marrow and grease per hour of processing. Phalanges provide good-quality fat even in malnourished animals (Binford, 1978, 24-25, 32; Speth, 1983, 102-104), but long-bone fragmentation argues against regular slaughter of sheep/goats in poor condition. More plausibly, large cattle carcasses provided sufficient protein and fat per consumer to discourage processing of their phalanges.

4.5.5 Carcass processing, cooking and consumption: synthesis

Sheep and goats, together comprising the majority of the EN Revenia-Korinou assemblage, apparently followed similar pathways of preparation for consumption. The dressed carcass, skinned and without the head, was usually subdivided into large sections (whole/part limbs), that were then cooked on the bone, probably in an oven (of which out-of-context remains were found) or pit. Stripped of meat, long-bone shafts and articulations were then broken for marrow and grease, respectively. The metapodials and phalanges 1-2 were similarly treated, sometimes after preparatory heating on a fire. Some raw meat was also filleted and prepared off the bone, perhaps by a fire given the lack of cooking pots.

Cattle and pigs were similarly treated, but more intensively dismembered (especially cattle) and filleted (both taxa). In cattle, at least, this was arguably a practical adjustment to large carcasses, but pigs were of intermediate size and mostly killed young. Alternatively, filleted meat of cattle and pigs was possibly preserved by drying, smoking (cf. Friesen, 2001) or sealing in fat, whereas scarce filleting of sheep and goats implies predominantly fresh consumption. Finally, although fragmentation of long-bone *shafts* was considerably more intensive in cattle than sheep/goats and pigs, long bone *articulations* and phalanx 1-2 were more intensively broken in sheep/goats than cattle (contrary to 'rational' expectations) or pigs, implying – at least – that cattle and sheep/goats were slaughtered in different commensal contexts.

Among game animals, small samples of aurochs and boar bones were more frequently cut or chopped than those of domestic cattle and pigs, but perhaps in subdividing their large carcasses for transport from a kill-site rather than in sharing them out. Frequent burning of hare, fox and badger, however, may indicate that small game were 'barbecued' whole or as joints on an open fire, rather than cooked in a pit or oven as usual for domesticates.

As regards within-bone fats, the cattle long bones in articulating groups from Pit 24 were broken mid-shaft in the manner reported for Nunamiut men at hunting camps, 'snacking' on marrow scooped or tapped from its cavity (Binford, 1978, 152-54). Usually, however, Revenia-Korinou long bones and phalanges 1-2 were more heavily splintered, albeit not to the degree observed ethnographically in pulverizing stock-piled long-bone articular ends for grease production (Binford, 1978, 154, 157-59). In lowland Greece, stock-piling for culinary use is impracticable outside winter (Outram, 2001, 402), while more opportunistically produced 'bone juice' (Binford, 1978, 163-65) would again have favoured articular comminution over the observed shaft splintering. In experimental grease recovery by boiling, however, fragmented articular ends do enhance extraction rate and especially time-efficiency (Church and Lyman, 2003; Janzen et al., 2014), and speed would be important where, as by default at Revenia-Korinou, boiling involved repeated addition of heated stones to a wooden or skin container rather than placing a pot on a fire (Binford, 1978, 159). Therefore, if articular ends at Revenia-Korinou were indeed fractured to facilitate grease extraction, the splintering (rather than breaking open) of long-bone shafts perhaps

indicates that marrow and grease were mainly retrieved *together*, boiling smashed bones in a single labour-saving process.

Bones yield modest amounts of fat and rendering bone grease particularly is often regarded as a response to scarcity (e.g. Speth and Spielmann, 1983; Outram, 2001). Alternatively, if meat was consumed infrequently at Revenia-Korinou (cf. Halstead and Isaakidou, 2013, 133), marrow and grease might have facilitated storage of filleted meat (cf. Morin and Soulier, 2017, 98; Halstead and Isaakidou, 2011b), but grease extraction seems most intensive in sheep and goats, which were least often filleted. More plausibly, even modest additions of marrow or grease would have enriched staple cereal dishes (as among the Nunamiut, accompanying dried meat – Binford, 1978, 163). If marrow and grease were largely extracted at Revenia-Korinou after or independently of cooking meat on the bone (as argued above), they could have been added to cereal dishes at meat-eating events or in the (probably lengthy) intervals between. Since the more cost-effective bone-grease of cattle was not intensively exploited, however, short- rather than long-term availability of animal protein and fat apparently shaped such decisions.

While combined splintering of long-bone articulations and shafts may have saved labour, it would also have limited opportunities for particular individuals to snack on the largest concentrations or highest quality of marrow, from upper and lower limbs respectively (Binford 1978, 23-25, 42-43; Morin, 2007). The inferred pattern of marrow and grease extraction may have been socially significant, therefore, in 'democratizing' or at least anonymizing access to within-bone nutrients of variable quality.

4.5.6 Carcass processing, cooking and consumption in social context

The rarity of weathered/abraded material and frequency (high for such fragmented material) of articulating specimens and old-break joins suggest that most animal bone in pit fills was deposited rapidly in its eventual find spot, or a nearby midden, without prolonged exposure on the surface. Clear differences between pits in density of ceramic, lithic, faunal and molluscan debris (Adaktylou, 2017) and, among the faunally richest pits, in species composition (abundant pigs in Pits 7, 18 and 24; abundant goats in Pit 11; rare cattle in Pit 2) and gnawing or burning also imply

derivation from short-term and/or very localised discard, rather than long-term refuse dispersal across the settlement. Moreover, in Pit 24, each articulating group of cattle bones came from a single excavation unit, precluding sufficiently lengthy accumulation in a midden for connecting tissue to decay.

Given rapid deposition, faunal contents may inform on the use of individual pits. Although some non-residential usage is suspected, and despite stark contrasts in pit contents, individual pits were apparently not associated with different stages of carcass processing. The eight faunally rich pits differ highly significantly in sheep/goat anatomical representation (MinAU, excluding neonatal specimens; χ^2 218.312, p = .000), but each broadly resembles the assemblage as a whole: small bones (phalanges, astragalus, calcaneum) are consistently underrepresented; and both meat-rich (humerus, radius, femur, tibia) and meat-poor (metacarpal, metatarsal) long bones are well represented (Figure 11).

Indications of short-lived and very localized discard raise the alternative possibility that fills of proposed residential pits contained remains of commensal events commemorating or sponsored by their original occupants. Consistent with this, burnt superstructural fragments in several pits perhaps indicate ceremonial destruction rather than abandonment and decay at end of use-life. While some observed variability in butchery processes arguably reflects practical issues of carcass size, commensal occasions were evidently differentiated by type(s) of animals slaughtered, their degree of partitioning for cooking, how they were cooked (on/off the bone; pit/oven/open fire), and (perhaps after the event) how intensively bones were broken for marrow and grease. To ‘insiders’, such differences probably signaled unambiguous distinctions of cultural context (e.g. marriage or funeral) and social relationships (e.g. eating with close neighbours or distant allies). Crucial to archaeological understanding of such differentiation is the scale of commensal episodes, but it is unclear whether pit fills contain remains of single or multiple events. Nonetheless, differences between species in carcass treatment perhaps imply consumption on separate occasions, while the otherwise puzzlingly intensive exploitation of sheep/goat phalanges is comprehensible if these small domesticates were slaughtered singly/in small numbers at different events, less generously provisioned with animal fat, than cattle.

Even if previous occupants or close neighbours discarded bones found in individual pits, carcass parts were apparently distributed more widely. Occurrences, within a pit, of suspected paired body parts are surprisingly rare (one case each for distal tibia and distal metatarsal of cattle), given the evidence for rapid deposition, suggesting that left and right sides of a carcass were usually dispersed before discard of bones. Moreover, none of the numerous matching articulations between anatomically adjacent bones bears cut marks indicating pre-discard dismemberment and only one of the numerous old-break joins between bone splinters involved the proximal and distal halves of a long bone (a sheep/goat radius from Pit 22). Thus, although intensive fragmentation reduces the likelihood of recognizing matches and joins, bones parted by dismembering (probably while covered in raw flesh) and likewise proximal and distal long bones separated by breakage (probably after cooking/heating) were also normally dispersed across the site. Phalanges too were routinely dispersed: only 3.2% of cattle, 3.5% of pig and 9.2% of the more numerous and intensively splintered sheep/goat specimens (MaxAU) were discounted in estimating MinAU, meaning that both first or both second phalanges from a foot were rarely (if ever) recovered from the same pit. Numerous matches of unfused diaphyses and epiphyses from the same pit confirm that dispersal of dismembered specimens, long-bone halves and paired phalanges did not simply result from post-discard processes.

5. Conclusions

The large, thoroughly retrieved and well preserved Revenia-Korinou faunal assemblage enables more detailed understanding of carcass processing than hitherto possible for EN Greece. First, in contrast with an apparent Bronze Age tendency to cook smaller joints and fillets (Isaakidou, 2007; Halstead, 2011), butchery marks on bone imply that domestic animals were here baked or roasted in large sections, probably in pits or ovens. This interpretation, confirmed by the lack of cooking pots at EN Revenia-Korinou, also supports similar interpretations of comparable butchery evidence at *later* Neolithic Makriyalos I (Halstead, 2007), Toumba Kremastis-Koiladas (Tzevelekidi, 2012) and Knossos (Isaakidou, 2007), where pots *were* used for cooking and some at least impregnated with animal adipose fats (Urem-Kotsou and Kotsakis, 2007).

Secondly, Revenia-Korinou exhibits intriguing differences between taxa in butchery and cooking. While whole limbs of sheep and goats were often cooked as single units (perhaps, given unusually modest evidence for dismembering the elbow, even more so than at later Neolithic sites), many cattle and pigs were butchered into smaller joints or their meat was filleted and presumably cooked off the bone. More intensive butchery is consistent in cattle with the practicalities of cooking large carcasses, but less clearly so in pigs. Perhaps cattle and pigs, apparently slaughtered more rarely than sheep/goats, were butchered more intensively for wider sharing. Regardless, practical considerations alone apparently did not shape differential butchery: at LN Toumba Kremastis-Koiladas (Tzevelekidi, 2012), sheep/goats were filleted more frequently than pigs (the reverse of Revenia-Korinou practice) and, at later Neolithic Knossos, the incidence of both dismembering and filleting was fairly similar in the three principal domestic taxa (Isaakidou, 2007).

Thirdly, as previously suggested from much smaller assemblages at nearby Paliambela-Kolindrou, Knossos on Crete (Halstead and Isaakidou, 2011a) and probably Argissa in central Greece (Boessneck, 1962, 27), EN extraction of marrow and especially grease was far more intensive than in later Neolithic and Bronze Age assemblages from the same regions. Before extracting marrow and grease at Revenia-Korinou, meaty long bones were heated during cooking, while foot bones were placed on/by a fire (perhaps to remove soft tissue, render them more brittle and/or liquefy their fat content). Articulations were broken sufficiently regularly to suggest retrieval of grease (to a degree that discouraged subsequent gnawing by dogs), while shafts were splintered more intensively than needed to extract marrow, so perhaps marrow and grease were removed together – for example by boiling with heated stones in an organic receptacle. If so, these fats maybe served primarily to enhance staple grain dishes. In sharp contrast with the division of carcasses for cooking, fragmentation of limb bone articulations was markedly more intensive in sheep/goats than cattle or pigs, even for the small phalanges 1-2 that offer poor returns on processing labour. Non-intensive exploitation of marrow and grease, in pigs perhaps due to its poor quality in young animals, may indicate that older and bigger cattle, even if slaughtered for larger commensal events than those featuring sheep/goats, provided more generous rations of animal fat and protein per participant.

The difficulty of rendering grease without cooking pots offers a tempting rationale for heavy EN articular fragmentation, but begs two questions: why early ceramics (e.g. at Revenia-Korinou and Paliambela-Kolindrou) were *not* used for this purpose; and why later Neolithic use of cooking pots accompanied greater scavenger attrition, implying *less thorough* anthropogenic grease extraction. Alternatively, heavy fragmentation was perhaps a response to scarcity of dietary fat, but the differential treatment of Revenia-Korinou cattle and sheep/goats implies that slaughtering decisions at least partly created any such scarcity. Whatever its practical or cultural rationale, intensive EN fragmentation and the suggested mixing of marrow/grease of variable quality and quantity from different body parts would have limited or masked differences in access, such as might arise among individuals snacking on bones around the fire (e.g. Speth, 1990), and thus helped to reinforce an egalitarian ethos and collective solidarity (as argued for the cooking together of meat from sacrificed and other animals in Classical Greece – Ekroth, 2007).

Fourthly, the Revenia-Korinou assemblage is overwhelmingly derived from pits, many interpreted on morphological grounds as underground components of dwellings. Pit fills largely postdate any original residential use, but stratigraphic, faunal and ceramic indicators suggest rapid deposition. Coupled with marked taxonomic and taphonomic variation, this suggests derivation of these fills from middens that accumulated during residential use of pits or from post-abandonment commensality commemorating such use. In either case, there is evidence for routine pre-discard dispersal across the site of uncooked joints (dismembering marks were not observed on matching articulating bones from the same pit), portions of rendered marrow and grease (numerous joins between old breaks included only one between proximal and distal long-bone halves), and probably also cooked meat (given the large size of carcass sections dismembered for cooking). Thus, in addition to revealing differential culinary treatment between sheep/goats, cattle and pigs, perhaps representing commensal occasions of variable scale and cultural rationale, Revenia-Korinou strengthens the argument that carcasses were distributed widely across the co-resident community – in this case, beyond the social groups that discarded faunal material found in individual pit fills. The discovery of only parts of even smaller domesticate carcasses in any one pit suggests that discarding social groups, perhaps (previous) occupants and/or immediate neighbours/kin, were only a small fraction of

the co-resident community. Given the lack of *in situ* artefacts and facilities associated with their use life (Adaktylou, 2017), it is unclear which activities suspected dwelling pits sheltered – whether they represented 'households' in the sense of residential units that stored and cooked food. Nonetheless, analysis of carcass processing and dispersal suggests a commensal distinction between small social units that routinely ate together and a wider community that shared or exchanged some carcass products.

Fifthly, if the distinguishing characteristic of domestic animals is their belonging to someone (Ingold, 1986, 113), carcasses of game should perhaps have been especially subject to sharing. Unfortunately, wild animals are too scarce at Revenia-Korinou for detailed analysis, but hints that small game was barbecued more frequently than domesticates may indicate that these two categories were treated and perceived differently. The distribution of *domestic* carcass parts should have placed recipients under some obligation to reciprocate (Barnard and Woodburn, 1991), but greater pressure cross-culturally to share cooked than raw meat (Sahlins, 1974, 125) suggests that the former perhaps promoted solidarity over indebtedness and inequality. If so, the cooking of carcasses in large sections and 'anonymising' of within-bone nutrients suggest emphasis on solidarity and (at least display of) equality at EN Revenia-Korinou. By contrast, more formal dressing (removal of feet as well as heads) and/or less thorough exploitation of marrow and, especially, grease at later Neolithic Knossos, Makriyalos I and Toumba Kremastis-Koiladas implies more competitive carcass use.

Detailed comparison between Revenia-Korinou and other assemblages is difficult, given the variety of recording protocols used, and lies beyond the scope of this paper. It is noteworthy, however, that intensive bone breakage, recalling that at Revenia-Korinou and other EN sites in Greece, is reported from early Neolithic Çatalhöyük in central Turkey (Russell and Martin, 2012) and, together with distinctively sparse canid-like gnawing, Ulucak Höyük in western Turkey (Çakırlar, 2012, 6 table 2) and Ecsegfalva in Hungary (Bartosiewicz, 2007, 287, 295). It was also usual in the Natufian Levant (e.g. Munro and Bar-Oz, 2005; Edwards and Martin, 2013) and in late Mesolithic (but *not* Neolithic) levels in eastern Spanish caves (Bernabeu Auban et al., 2001), and so apparently widely characteristic of late foraging and earliest farming populations. In these more distant cases, intensive fragmentation has been attributed

to scarcity of human dietary fat (e.g. Bernabeu Auban et al., 2001, 601) or the difficulty of rendering grease without cooking pots, but the counter-arguments presented for Revenia-Korinou again deserve consideration. If intensive bone fragmentation widely represented a social leveling, as much as resource maximizing, strategy on either side of the agricultural transition, it may have played a significant role in dampening, albeit temporarily, fissive tendencies arising from 'privatisation' of domestic animals and grain stores.

6. Acknowledgements

We thank Manthos Besios, excavator (with Adaktylou) of Revenia-Korinou, for granting Isaakidou and Halstead the opportunity to study this exceptional faunal assemblage, and Duskha Urem-Kotsou, for advice on the chronological implications of the ceramic assemblage. The faunal material was studied partly at the Makriyalos study centre, with the assistance of the exceptional staff of the 16th Eforia Proistorikon kai Klasikon Arkhaiotiton (now Eforia Arkhaiotiton Pierias), and partly in the Fitch Laboratory of the British School at Athens, where the director, Evangelia Kiriatzi, generously provided study and storage space. Angelos Gotsinas, Vaso Tzevelekidi and Frank Woodger kindly assisted in transport, sorting and identification of the assemblage. Duskha Urem-Kotsou, Ingrid Mainland, Caroline Jackson and two anonymous reviewers offered valuable comments on interpretation of ceramic and faunal evidence for carcass processing and cooking and on the clarity of draft texts. Fieldwork was funded by: the Institute for Aegean Prehistory (INSTAP); the University of Sheffield; the co-financed European Union (European Social Fund)/Greek (National Strategic Reference Framework) Operational Program 'Education and Lifelong Learning' (Research Funding Program: Thales. Investing in knowledge society through the European Social Fund – project 'Material Culture & Environment: Exploitation of Natural Resources during the Neolithic in N. Greece'); and the authors.

ACCEPTED MANUSCRIPT

7. *References*

Adaktylou, F. 2017. O Neolithikos Oikismos sta Revenia Korinou Pierias. MA thesis. Dept. of History and Archaeology, Aristotle University of Thessaloniki.

Barnard, A., Woodburn, J., 1991. Property, power and ideology in hunting and gathering societies: an introduction. In: Ingold, T., Riches, D., Woodburn, J. (Eds.), Hunters and Gatherers, 2: Property, Power and Ideology. Berg, Oxford, pp. 4-31.

Bartosiewicz, L., 2007. Mammalian bone. In: Whittle, A., The Early Neolithic on the Great Hungarian Plain: Investigations of the Körös Culture Site of Ecsegfalva 23, Co. Békés. Institute of Archaeology, Hungarian Academy of Sciences, Budapest, pp. 287-325.

Bernabeu Auban, J., Barton, C.M., Ripoll, M.P., 2001. A taphonomic perspective on Neolithic beginnings: theory, interpretation, and empirical data in the western Mediterranean. J. Archaeol. Sci. 28, 597-612.

Besios, M., Adaktylou, F., 2006. Neolithikos oikismos sta 'Revenia' Korinou. To Arkhaiologiko Ergo sti Makedonia kai Thraki 18, 357-366.

Binford, L.R., 1978. Nunamiut Ethnoarchaeology. Academic Press, New York.

Binford, L.R., 1981. Bones: Ancient Men and Modern Myths. Academic Press, New York.

Blasco, R., Domínguez-Rodrigo, M., Arilla, M., Camarós, E., Rosell, J., 2014. Breaking bones to obtain marrow: a comparative study between percussion by batting bone on an anvil and hammerstone percussion. Archaeometry 56(6), 1085-1104.

Boessneck, J., 1962. Die Tierreste aus der Argissa-Magula vom präkeramischen Neolithikum bis zur mittleren Bronzezeit. In: Milojčić, V., Boessneck, J., Hopf, M., Argissa-Magula 1: das Präkeramische Neolithikum sowie die Tier- und Pflanzenreste. Habelt, Bonn, pp. 27-99.

Boessneck, J., Müller, H.-H., Teichert, M., 1964. Osteologische Unterscheidungsmerkmale zwischen Schaf (Ovis aries Linné) und Ziege (Capra hircus Linné). Kühn-Archiv 78, 1-29.

Brain, C.K., 1981. The Hunters or the Hunted? Chicago University Press, Chicago.

Çakırlar, C., 2012. The evolution of animal husbandry in Neolithic central-west Anatolia: the zooarchaeological record from Ulucak Höyük (c. 7040–5660 cal. BC, Izmir, Turkey). Anatolian Studies 62, 1-33.

Chan, B.T., Gkotsinas, A., Halstead, P., Isaakidou, V., Tsoraki, C., Tzevelekidi, V.,

2010. Experimental butchery with stone tools: a preliminary report. Lithics 31, 152-155.

Church, R.R., Lyman, R.L., 2003. Small fragments make small differences in efficiency when rendering grease from fractured artiodactyl bones by boiling. J. Archaeol. Sci. 30 (8), 1077-1084.

Domínguez-Rodrigo, M., Yravedra, J., 2009. Why are cut mark frequencies in archaeofaunal assemblages so variable? A multivariate analysis. J. Archaeol. Sci. 36, 884-894.

Driesch, A. von den, 1976. A Guide to the Measurement of Animal Bones from Archaeological Sites. Peabody Museum, Harvard.

Edwards, Y.H., Martin, L., 2013. Animal bones and archaeozoological analysis. In: Edwards, P.C. (Ed.), Wadi Hammeh 27, an Early Natufian Settlement at Pella in Jordan. Brill, Leiden, pp. 321-352.

Ekroth, G., 2007. Meat in ancient Greece: sacrificial, sacred or secular? Food and History 5 (1), 249-272.

Friesen, T.M., 2001. A zooarchaeological signature for meat storage: re-thinking the Drying Utility Index. American Antiquity 66 (2), 315-331.

Greenfield, H.J., 1988. Bone consumption by Serbian pigs in a contemporary Serbian village: implications for the interpretation of prehistoric faunal assemblages. Journal of Field Archaeology 15, 473-479.

Halstead, P., 2004. Farming and feasting in the Neolithic of Greece: the ecological context of fighting with food. Documenta Praehistorica 31, 151-161.

Halstead, P., 2007. Carcasses and commensality: investigating the social context of meat consumption in Neolithic and Early Bronze Age Greece. In: Mee, C., Renard, J. (Eds.), Cooking Up the Past: Food and Culinary Practices in the Neolithic and Bronze Age Aegean. Oxbow, Oxford, pp. 25-48.

Halstead, P., 2011. The faunal remains. In: D. Pullen, Nemea Valley Archaeological Project I: The Early Bronze Age Village on Tsoungiza Hill. American School of Classical Studies at Athens, Princeton, pp. 741-803.

Halstead, P., Collins, P., Isaakidou, V., 2002. Sorting the sheep from the goats: morphological distinction between mandibles and mandibular teeth of adult Ovis and Capra. J. Archaeol. Sci. 29 (5), 545-553.

Halstead, P., Isaakidou, V., 2011a. Political cuisine: rituals of commensality in the Neolithic and Bronze Age Aegean. In: Aranda Jiménez, G., Montón-Subías, S.,

Romero, S. (Eds.), Guess Who's Coming to Dinner. Feasting Rituals in the Prehistoric Societies of Europe and the Near East. Oxbow, Oxford, pp. 91-108.

Halstead, P., Isaakidou, V., 2011b. A pig fed by hand is worth two in the bush: ethnoarchaeology of pig husbandry in Greece and its archaeological implications. In: Albarella, U., Trentacoste, A. (Eds.), Ethnozooarchaeology: the Present and Past of Human-Animal Relationships. Oxbow, Oxford, pp. 160-174.

Halstead, P., Isaakidou, V., 2013. Early stock-keeping in Greece. In: Colledge, S., Conolly, J., Dobney, K., Manning, K., Shennan, S. (Eds.), The Origins and Spread of Stock-Keeping in the Near East and Europe. Left Coast Press, Walnut Creek, pp. 129-144.

Helmer, D., Courtin, J., 1991. Sur l'emploi de la percussion lancée en boucherie préhistorique, apports de l'expérimentation. In: Archéodrome de Bourgogne (Eds.), Archéologie expérimentale, 2: la terre, l'os et la pierre, la maison et les champs. Editions Errance, Paris, pp. 39-45.

Ingold, T., 1986. The Appropriation of Nature: Essays on Human Ecology and Social Relations. Manchester University Press, Manchester.

Isaakidou, V., 2004. Bones from the Labyrinth: Faunal Evidence for the Management and Consumption of Animals at Neolithic and Bronze Age Knossos, Crete. PhD thesis, Institute of Archaeology, University College London.

Isaakidou, V., 2006. Ploughing with cows: Knossos and the 'secondary products revolution'. In: Serjeantson, D., Field, D. (Eds.), Animals in the Neolithic of Britain and Europe. Oxbow, Oxford, pp. 95-112.

Isaakidou, V., 2007. Cooking in the labyrinth: exploring 'cuisine' at Bronze Age Knossos. In: Mee, C., Renard, J. (Eds.), Cooking Up the Past: Food and Culinary Practices in the Neolithic and Bronze Age Aegean. Oxbow, Oxford, pp. 5-24.

Janzen, A., Reid, R.E.B., Vasquez, A., Gifford-Gonzalez, D., 2014. Smaller fragment size facilitates energy-efficient bone grease production. J. Archaeol. Sci. 49, 518-523.

Kalogiropoulou, E., 2014. Anazitontas koinonikes tavtotites: i symvoli ton thermikon kataskevon stin organosi tou khorou sti neolithiki Makedonia. In: Stefani, E., Merousis, N., Dimoula, A. (Eds.), A Century of Research in Prehistoric Macedonia. Archaeological Museum of Thessaloniki, Thessaloniki, pp. 359-372.

Kent, S., 1993. Variability in faunal assemblages: the influence of hunting skill, sharing, dogs, and mode of cooking on faunal remains at a sedentary Kalahari community. Journal of Anthropological Archaeology 12, 323-385.

Kotsakis, K., 1999. What tells can tell: social space and settlement in the Greek Neolithic. In: Halstead, P. (Ed.), Neolithic Society in Greece. Sheffield Academic Press, Sheffield, 66-76.

Kotsakis, K., 2006. Settlement of discord: Sesklo and the emerging household. In: Tasić, N., Grozdanov, C. (Eds.), Homage to Milutin Garašanin. Serbian Academy of Sciences and Arts, Macedonian Academy of Sciences and Arts, Belgrade, pp. 207-220.

Kratochwil, Z., 1969. Species criteria on the distal section of the tibia in Ovis ammon f. aries L. and Capra aegagrus f. hircus L.. Acta Veterinaria (Brno) 38, 483-490.

Lister, A., 1996. The morphological distinction between bones and teeth of fallow deer (Dama dama) and red deer (Cervus elaphus). International Journal of Osteoarchaeology 6, 119-143.

Lyman, R.L., 1994a. Quantitative units and terminology in zooarchaeology. American Antiquity 59(1), 36-71.

Lyman, R.L., 1994b. Vertebrate Taphonomy. Cambridge University Press, Cambridge.

Lymperaki, M., Urem-Kotsou, D., Kotsos, S., Kotsakis, K., 2016. Household scales: what cooking pots can tell us about households in the Late Neolithic Stavroupoli (Northern Greece). Open Archaeology 2, 328-344.

Maniatis, Y., 2014. Khronologisi me anthraka-14 ton megalon politismikon allagon stin proistoriki Makedonia: prosfates exelixeis. In: Stefani, E., Merousis, N., Dimoula, A. (Eds.), A Century of Research in Prehistoric Macedonia. Archaeological Museum of Thessaloniki, Thessaloniki, pp. 205-222.

Maniatis, Y., Kotsakis, K., Halstead, P., 2015. Paliambela Kolindrou. Nees khronologies tis arkhaioteris neolithikis sti Makedonia. To Arkhaiologiko Ergo sti Makedonia kai Thraki 25 (2011), 149-156.

Morin, E., 2007. Fat composition and Nunamiut decision-making: a new look at the marrow and bone grease indices. J. Archaeol. Sci. 34, 69-82.

Morin, E., Soulier, M.-C., 2017. New criteria for the archaeological identification of bone grease processing. American Antiquity 82 (1), 96-122.

Munro, N.D., Bar-Oz, G., 2005. Gazelle bone fat processing in the Levantine Epipalaeolithic. J. Archaeol. Sci. 32, 223-239.

Munro, N.D., Stiner, M.C., 2015. Zooarchaeological evidence for Early Neolithic colonization at Franchthi Cave (Peloponnese, Greece). Current Anthropology 56 (4),

596-603.

Outram, A.K., 2001. A new approach to identifying bone marrow and grease exploitation: why the 'indeterminate' fragments should not be ignored. J. Arch. Sci. 28, 401-410.

Outram, A.K., 2002. Bone fracture and within-bone nutrients: an experimentally based method for investigating levels of marrow extraction. In: Miracle, P., Milner, N. (Eds.), Consuming Passions and Patterns of Consumption. McDonald Institute, Cambridge, pp. 51-63.

Papaioannou, A., 2010. I Keramiki apo tous Lakkous 7 kai 11 tis Proimis Neolithikis Thesis Revenion Korinou. MA thesis, Dept. of History and Archaeology, Aristotle University of Thessaloniki.

Pappa, M., 2008. Organosi tou Khorou kai Oikistika Stoikhia stous Neolithikous Oikismous tis Kentrikis Makedonias: D. E. Th - Thermi - Makriyalos. PhD thesis, Department of History and Archaeology, Aristotle University of Thessaloniki.

Pappa, M., Halstead, P., Kotsakis, K., Urem-Kotsou, D., 2004. Evidence for large-scale feasting at Late Neolithic Makriyalos, N Greece. In: Halstead, P., Barrett, J.C. (Eds.), Food, Cuisine and Society in Prehistoric Greece. Oxbow, Oxford, pp. 16-44.

Payne, S., 1985a. Morphological distinctions between the mandibular teeth of young sheep, Ovis, and goats, Capra. J. Archaeol. Sci. 12, 139-147.

Payne, S., 1985b. Zoo-archaeology in Greece: a reader's guide. In: Wilkie, N.C., Coulson, W.D.E. (Eds.), Studies in Honor of William A. McDonald. University of Minnesota Press, Minneapolis, pp. 211-244.

Prummel, W., Frisch, H.-J., 1986. A guide for the distinction of species, sex and body side in bones of sheep and goat. J. Archaeol. Sci. 13, 567-577.

Russell, N., Martin, L., 2012. Cooking meat and bones at Neolithic Çatalhöyük, Turkey. In: Graff, S., Rodríguez-Alegría, E. (Eds.), The Menial Art of Cooking: Archaeological Studies of Cooking and Food Preparation. University Press of Colorado, Boulder, pp. 87–97.

Sahlins, M., 1974. Stone Age Economics. Tavistock Publications, London.

Saladié, P., Rodríguez-Hidalgo, A., Díez, C., Martín-Rodríguez, P., Carbonell, E., 2013. Range of bone modifications by human chewing. J. Archaeol. Sci. 40, 380-397.

Silva García, T., 2011. Biographies of Pits 34 and 26 at the Early Neolithic Site of Korinos-Revenia, Greece. MA thesis, Dept. of Archaeology, University of Sheffield.

Speth, J., 1983. Bison Kills and Bone Counts. Chicago University Press, Chicago.

Speth, J.D., 1990. Seasonality, resource stress, and food sharing in so-called 'egalitarian' foraging societies. Journal of Anthropological Archaeology 9, 148-188.

Speth, J.D., 2000. Boiling vs. baking and roasting: a taphonomic approach to the recognition of cooking techniques in small mammals. In: Rowley-Conwy, P. (Ed.), Animal Bones, Human Societies. Oxbow, Oxford, pp. 89-105.

Speth, J.D., Spielmann, K.A., 1983. Energy source, protein metabolism, and hunter-gatherer subsistence strategies. Journal of Anthropological Archaeology 2, 1-31.

Stallibrass, S., 1984. The distinction between the effects of small carnivores and humans on post-glacial faunal assemblages. In: Grigson, C., Clutton-Brock, J. (Eds.), Animals and Archaeology 4: Husbandry in Europe. BAR International Series 227. British Archaeological Reports, Oxford, 259-269.

Thoms, A.V., 2008. The fire stones carry: ethnographic records and archaeological expectations for hot-rock cookery in western North America. Journal of Anthropological Archaeology 27, 443-460.

Tomkins, P., 2007. Communality and competition: the social life of food and containers at Aceramic and Early Neolithic Knossos, Crete. In: Mee, C., Renard, J. (Eds.), Cooking Up the Past: Food and Culinary Practices in the Neolithic and Bronze Age Aegean. Oxbow, Oxford, pp. 174-199.

Tzevelekidi, V., 2012. Dressing for Dinner: Butchery and Bone Deposition at Late Neolithic Toumba Kremastis-Koiladas, Northern Greece. BAR International Series 2451. Archaeopress, Oxford.

Tzevelekidi, V., Halstead, P., Isaakidou, V., 2014. Invitation to dinner: practices of animal consumption and bone deposition at Makriyalos I (Pieria) and Toumba Kremastis-Koiladas (Kozani). In: Stefani, E., Merousis, N., Dimoula, A. (Eds.), A Century of Research in Prehistoric Macedonia. Archaeological Museum of Thessaloniki, Thessaloniki, pp. 425-436.

Urem-Kotsou, D., 2017. Storage of food in the Neolithic communities of northern Greece. World Archaeol. 49 (1), 73-89.

Urem-Kotsou, D., in press. Breath of change: food and pottery in the course of the Neolithic in Northern Greece. In: Ivanova-Bieg, M., Stockhammer, P.W., Athanassov, B., Petrova, V., Takorova, D. (Eds.), Social Dimensions of Food in the Prehistory of the Eastern Balkans and Neighbouring Areas. Oxbow, Oxford.

Urem-Kotsou, D., Kotsakis, K., 2007. Pottery, cuisine and community in the Neolithic of north Greece. In: Mee, C., Renard, J. (Eds.), Cooking Up the Past: Food

and Culinary Practices in the Neolithic and Bronze Age Aegean. Oxbow, Oxford, 225-246.

Urem-Kotsou, D., Papaioannou, A., Silva, T., Adaktylou, F., Besios, M., 2015. Oikismos arkhaioteris kai mesis neolithikis sta Revenia Korinou: prota apotelesmata tis meletis tis keramikis. To Arkhaiologiko Ergo sti Makedonia kai Thraki 25, 163-172.

Veen, M. van der, Fieller, N., 1982. Sampling seeds. J. Archaeol. Sci. 9, 287-298.

Vainshtein, S., 1980. Nomads of South Siberia: the Pastoral Economies of Tuva. Cambridge University Press, Cambridge.

Yellen, J.E., 1991. Small mammals: post-discard patterning of !Kung San faunal remains. Journal of Anthropological Archaeology 10, 152-192.

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Figure 1. Map of Greece, showing the location of Revenia-Korinou and other Neolithic sites mentioned in the text

Key: 1 Revenia-Korinou, 2 Paliambela-Kolindrou, 3 Makriyalos I, 4 Toumba Kremastis-Koiladas, 5 Agios Petros, 6 Argissa, 7 Seskło, 8 Achilleion, 9 Prodromos 1-2, 10 Doliana, 11 Franchthi Cave, 12 Knossos

Figure 2 [**black & white version**]. Plan of Revenia-Korinou, showing excavated EN features

Key: hatched fill indicates pits identified during excavation as ceramic-rich

dark-grey fill indicates pits identified during excavation as bone-rich

light-grey fill indicates the eight pits subject to detailed faunal analysis (of which Pits 18, 24, 42, 48 and 51 were originally identified as bone-rich and Pits 2, 7 and 11 as ceramic-rich)

Figure 2 [**colour version**]. Plan of Revenia-Korinou, showing excavated EN features

Key: orange fill indicates pits identified during excavation as ceramic-rich

green fill indicates pits identified during excavation as bone-rich

blue fill indicates the eight pits subject to detailed faunal analysis (of which Pits 18, 24, 42, 48 and 51 were originally identified as bone-rich and Pits 2, 7 and 11 as ceramic-rich)

Figure 3. Anatomical representation of common domestic taxa (MinAU**;** excluding neonatal specimens; numbers of phalanx 1-3 halved, because phalanges of the fore-and hind-foot were not differentiated systematically)

Key: MD mandible, SC scapula, H humerus, R radius, U ulna, MC metacarpal, PE pelvis, F femur, T tibia, A astragalus, C calcaneum, MT metatarsal, PH1-3 phalanx 1-3, p proximal, d distal

Figure 4. Washed animal bones from Pit 51, excavation unit #038012, in advance of sorting, exemplifying fragmented state of the assemblage

Figure 5. Examples of matching distal tibia diaphysis and epiphysis (sheep and goat) and articulating distal tibia and astragalus (sheep) from Pit 51, excavation unit #038012

ACCEPTED MANUSCRIPT

Figure 6. Articulating left distal humerus, proximal radius and proximal ulna of cattle, cemented by sediment in correct anatomical position, from Pit 5β, excavation unit #021003.

Key: 1 chop through distal shaft of humerus, 2 impact area on proximal shaft of radius

Figure 7. Anatomical distribution of butchery marks in cattle

Key: arrow = chop mark, line = knife mark
D dismembering, F filleting, F* ?cleaning of metapodial for breakage, H ?hanging, Sk skinning
1,2,3 etc. numbers of specimens with cuts
** ribs identified only to size category (cattle-size)
Note that the location of cut symbols within each bone is arbitrary, as is the assignation of cuts to fore and hind phalanges

Figure 8. Anatomical distribution of butchery marks in sheep/goats

Key: arrow = chop mark, line = knife mark
D dismembering, F filleting, F* ?cleaning of metapodial for breakage, Sk skinning
1,2,3 etc. numbers of specimens with cuts
** ribs identified only to size category (sheep/goat-size)
Note that the location of cut symbols within each bone is arbitrary, as is the assignation of cuts to fore and hind phalanges

Figure 9. Anatomical distribution of butchery marks in pigs

Key: arrow = chop mark, line = knife mark
D dismembering, F filleting, Sk skinning
1,2,3 etc. numbers of specimens with cuts
Note that the location of cut symbols within each bone is arbitrary, as is the assignation of cuts to fore and hind phalanges

Figure 10. Examples of fractured phalanx 1-2 and intact phalanx 3 specimens of sheep/goat from Pit 51, excavation unit #038013

Figure 11. Anatomical representation of sheep/goats for eight faunally rich contexts (MinAU**;** excluding neonatal specimens; numbers of phalanx 1-3 halved, because phalanges of the fore- and hind- foot were not differentiated systematically)

Key: see Figure 3

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Context*	Date**	Total	Cattle	Pig	Sheep	Sheep/ Goat	Goat	Dog	Aurochs	Boar	Red deer	Fallow deer	Roe deer	Fox	Badger	Bear	Hare	Hedgehog	Tortoise
F1		48	2	3	3	38	1							1					
G1		5				5													
P2	ENI	493	14	45	85	301	29	2		1		2	1	6	1		6		
P3		45	12	4	9	19	1												
P4	ENII-III	162	12	35	27	79	7	1		1									
P5	ENII	167	19	19	26	84	12	3			2		1				1		
P6	*ENI-III*	217	30	20	34	117	12	2						1			1		
P7	ENII	584	69	96	82	295	23	2	2	1		2		10					2
P9	*ENI-III*	13	4		2	7													
P10	*ENI-III*	41	8	5	6	19	3												
P11	ENI	412	75	33	53	211	31		6			1					2		
P11/20	ENI	13	3	1	3	4	2												
P12	*ENI-III*	19	3	5	1	6	3					1							
P13		7	2			4											1		
P14		6	2	1		3													
P15	*ENI/II*	29	7	3	3	16													
P16		16	2	3	3	7							1						
P16/17		28	2	6	3	15	1							1					
P17	ENII	55	16	2	8	25	1		1	1				1					
P17/27		2			1	1													
P18	ENI	837	58	167	142	414	38		1	2		3	11		1				
P20	*ENI*	282	36	36	44	140	24					1					1		
P21	*ENI*	96	13	15	22	42	2										2		
P22		12			2	8							2						
P23	*ENI*	146	12	16	28	74	9			4		1					2		
P24	ENI	843	139	151	165	329	40	6	1	4				2			4	2	
P25		124	18	13	24	61	7							1					
P26	ENII	263	57	41	34	110	18							2			1		
P27		44	4	3	14	22											1		
P28		28	4		7	14											1		2
P29		316	36	33	37	183	21					2	2					1	1
P30		17	6	3	2	5											1		
P31		2	1			1													
P32		15	4	1	2	7	1												
P33	*ENI*	108	6	10	23	59	6	1				1		1			1		
P34	*ENI*	162	22	20	28	85	7												
P35		12	5	2	2	3													
P36		89	10	10	16	47	5							1					
P37		65	20	20	4	16	5												
P38		2				2													

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

P39		203	44	19	32	92	9		3		2	1	1							
P40		16	1	4	2	8			1											
P41	ENI	129	2	17	19	81	9					1								
P42	ENI	438	54	56	87	197	24	2		5	1	1	5	4		2				
P43	ENII	66	4	6	13	37	2			1				2			1			
P44	ENII	234	37	37	47	100	10	1	1				1							
P45	*ENII-III*	243	42	44	44	101	8			1	1		1				1			
P46	*ENII-III*	261	47	32	40	130	9			1	1						1			
P47	ENI	295	22	41	46	172	7			1	1	1	1				2			1
P48	ENI	452	90	53	70	210	22		2			2	2					1		
P49	ENII	45	5	1	5	31	3													
P50	*ENI-II*	57	5	8	6	34	2						1							1
P51	*ENI*	365	41	32	70	193	22	1		2				2			2			
P52		58	5	4	9	33	2					1	4							
P53	*ENI*	61	2	4	12	40	2					1								
P56	*ENI*	101	5	18	14	59	5													
P57	*ENI*	90	12	24	18	34	2													
P58	*ENI*	106	9	17	15	57	1	1		2				2			2			
P59	*ENI*	23	2	2	3	15							1							
P60		5	1	3		1														
P62		19	3	5	3	7	1													
P63	*ENII-III*	69	13	6	9	37	4													
P64	*ENII-III*	6		1	1	2		1				1								
P66		26	12	5	2	5						1	1							
P67		84	12	9	16	42	3		1				1							
P68		1				1														
P69		17	3	3	7	3							1							
P70	*ENI*	44	6	4	7	24	2		1											
P71		17	1	4	3	8											1			
P72	ENI	128	20	26	17	55	10													
P73		8	3		1	4														
P74		25	3	1	1	15	1		1			3								
P75		1				1														
P76		8	3	3		2														
P77	*ENI*	12	2	1	3	5							1							
P78	*ENI-II*	3	2		1															
P79	*ENI-II*	2	2																	
P81	*ENI*	5	1		2	2														
P82		6	1		1	3	1													
P84		2				2														
P85		1				1														
Total	MinAU	9557	1250	1312	1571	4722	470	23	21	27	8	27	39	37	2	2	35	4	7	
	%***	-	13.1	13.7	54.5		16.3	0.2	0.2	0.3	0.1	0.3	0.4	0.4	<0.1	<0.1	0.4	<0.1	0.1	

Table 1. Identified specimens (MinAU) by species and context

ACCEPTED MANUSCRIPT

Key: F floor, G gulley, P pit
*Pit 3 combined with 3α & 3β; Pit 5 with 5β; Pit 11 with 19; Pit 24 with 55; Pit 29 with 29α, 29β, 29γ, 29δ & 29ε; Pit 39 with 39α, 39β & 39γ; Pit 45 with 45α; Pit 46 with 46α, 46β, 46γ & 46δ; Pit 48 with 48α, 48β & 48γ
** dates in *italics* based on pit intersections; otherwise on C^{14} determinations from basal levels of each pit.
*** with *pro rata* re-assignment to sheep or goat of specimens identified only to sheep/goat

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Pit	Cow		Pig		Sheep*		Sh/Gt	Goat*		Dog		Wild		Total
	MinAU	%	MinAU	%	MinAU	%	MinAU	MinAU	%	MinAU	%	MinAU	%	MinAU
2	14	2.8	45	9.1	85	62.8	301	29	21.4	2	0.4	17	3.4	493
7	69	11.8	96	16.4	82	53.5	295	23	15.0	2	0.3	17	2.9	584
11	75	18.2	33	8.0	53	45.2	211	31	26.4	0	0.0	9	2.2	412
18	58	6.9	167	20.0	142	56.0	414	38	15.0	0	0.0	18	2.2	837
24	139	16.5	151	17.8	165	51.0	329	40	12.4	6	0.7	13	1.5	843
42	54	12.3	56	12.8	87	55.1	197	24	15.2	2	0.5	18	4.1	438
48	90	19.9	53	11.7	70	50.8	210	22	16.0	0	0.0	7	1.5	452
51	41	11.2	32	8.8	70	59.4	193	22	18.7	1	0.3	6	1.6	365

Table 2. Identified specimens by species in eight faunally richest contexts

* %s include *pro-rata* re-assignment to sheep and goat of specimens identified only to sheep/goat

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

	Cattle		Pig		Sheep/Goat	
	MinAU	ratio	MinAU	ratio	MinAU	ratio
MCd+MTd	111	1.0	63	1.0	681	1.0
PH1	69	0.6	44	0.7	266	0.4
PH2	65	0.6	24	0.4	73	0.1
PH3	47	0.4	15	0.2	43	0.1

Table 3. Anatomical evidence for recovery losses: ratios of distal metapodials to phalanx 1-3 in common domestic taxa (excluding neonatal specimens)

Key: MC metacarpal, MT metatarsal, d distal, PH1 1st phalanx, PH2 2nd phalanx, PH3 3rd phalanx

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

	Cattle		Pig		Sheep/Goat	
	MinAU	ratio	MinAU	ratio	MinAU	ratio
Td	64	1.0	71	1.0	360	1.0
A	34	0.5	17	0.2	148	0.4
C	39	0.6	31	0.4	136	0.4
MTp	76	1.2	26	0.4	443	1.2

Table 4. Anatomical evidence for recovery losses: ratios of distal tibia to astragalus, calcaneum and proximal metatarsal in common domestic taxa (excluding neonatal specimens)

Key: T tibia, d distal, A astragalus, C calcaneum, MT metatarsal, p proximal

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

	Cattle	Pig	Sheep/ Goat
gnawed (MaxAU)	176	267	816
not gnawed (MaxAU)	1118	1082	6590
% gnawed	13.6	19.8	11.0
χ^2	χ^2 81.727, p = .000		

Table 5. Incidence of gnawing(/ingestion) in common domestic taxa (excluding neonatal and weathered/eroded specimens, and loose teeth)

ACCEPTED MANUSCRIPT

Pit		Cattle	Pig	Sheep/ Goat	Total
2	gnawed (MaxAU)	2	8	37	47
	not gnawed (MaxAU)	13	37	392	442
	% gnawed	13.3	17.8	8.6	9.6
7	gnawed (MaxAU)	15	20	55	90
	not gnawed (MaxAU)	60	74	397	531
	% gnawed	20.0	21.3	12.2	14.5
11	gnawed (MaxAU)	9	6	33	48
	not gnawed (MaxAU)	63	27	264	354
	% gnawed	12.5	18.2	11.1	11.9
18	gnawed (MaxAU)	13	48	102	163
	not gnawed (MaxAU)	62	151	727	940
	% gnawed	17.3	24.1	12.3	14.8
24	gnawed (MaxAU)	36	60	130	226
	not gnawed (MaxAU)	130	118	538	786
	% gnawed	21.7	33.7	19.5	22.3
42	gnawed (MaxAU)	8	11	31	50
	not gnawed (MaxAU)	38	46	295	379
	% gnawed	17.4	19.3	9.5	11.7
48	gnawed (MaxAU)	13	5	42	60
	not gnawed (MaxAU)	80	48	281	409
	% gnawed	14.0	9.4	13.0	12.8
51	gnawed (MaxAU)	4	3	13	20
	not gnawed (MaxAU)	38	30	287	355
	% gnawed	9.5	9.1	4.3	5.3
All		χ^2 6.472, p = .486	χ^2 22.294, p = .002	χ^2 57.966, p = .000	χ^2 91.639, p = .000

Table 6. Incidence of gnawing(/ingestion) in common domestic taxa in faunally rich pits (excluding neonatal and weathered/eroded specimens, and loose teeth)

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

		Cattle	Pig	Sheep/ Goat
a. long bones	whole (MaxAU)	2	8	3
	old break (MaxAU)	774	896	5368
	% whole	0.3	0.9	0.1
	χ^2	χ^2 29.157, p = .000		
b. long bones	shaft cylinder (MaxAU)	11	61	215
	whole/splintered end (MaxAU)	434	384	2383
	% cylinder	2.5	13.7	8.3
	χ^2	χ^2 37.230, p = .000		
c. long-bone articulations	whole end (MaxAU)	134	97	359
	end splinter (MaxAU)	300	287	2024
	% end splinters	69.1	74.7	84.9
	χ^2	χ^2 74.576, p = .000		
d. phalanx 1-2	whole (MaxAU)	60	24	70
	old break (MaxAU)	63	35	282
	% broken	51.2	59.3	81.1
	χ^2	χ^2 41.611, p = .000		

Table 7. Fragmentation of long bones and phalanx 1-2 in common domestic taxa (excluding new breaks and neonatal specimens)

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Pit	Matching unfused epiphysis & diaphysis	Articulating						Long-bone pair	Fragments joining at old break
		Left & right MD	Hd-Rp-Up	Rd-Carpals-MCp	Td-A-C-NC-MTp	MC/MT3 & MC/MT4 (dog/pig)	PH 1-2-3		
2	2				4		2		8
3	2								
4	6							2	2
5	2		3				2		
6	6								2
7	12		2						2
11	2		2						2
18	24		2		2				14
20	8								
21	2								
22									3
23			2		4		2		9
24	24		4	9	16	4		2	31
26	6			2	2				6
29	2	2	2						3
32	2								
36									3
39			2		2				2
42	14		2		6				
45			4			2			2
46	2								
47	4								
48	2				2				6
51	16				4				2
57		2							
58	2					2			
70	2								
72					2				
74									2
82	2								
Total	144	4	25	11	44	8	6	4	99

Table 8. Numbers of articulating specimens, pairs and old-break joins by context

MD mandible, H humerus, R radius, U ulna, MC metacarpal, T tibia, A astragalus, C calcaneum, NC navicular cuboid, MT metatarsal, PH phalanx, d distal, p proximal

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

		Cattle	Pig	Sheep/Goat	Dog	Aurochs	Boar	Red deer	Fallow Deer	Roe Deer	Fox	Badger	Bear	Hare	Hedgehog	Tortoise	Total
Uncut	MaxAU	1229	1334	7423	25	14	24	7	25	40	37	2	2	36	4	7	10209
Knife	MaxAU	92*	55	133	0	6	3	0	1	1	0	0	0	0	0	0	291*
	%	6.9	4.0	1.8	0.0	28.6	11.1	0.0	3.8	2.4	0.0	0.0	0.0	0.0	0.0	0.0	2.8
	χ^2	χ^2 122.506, p = .000															
Chop	MaxAU	12*	0	3	0	1	0	0	0	0	0	0	0	0	0	0	16*
	%	0.9	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	χ^2	χ^2 54.832, p = .000															
Total	MaxAU	1332	1389	7559	25	21	27	7	26	41	37	2	2	36	4	7	10515

Table 9. Incidence of knife and chop marks by taxon (excluding weathered/eroded specimens and loose teeth)

* including one cattle specimen with both knife and chop marks

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

	Cattle	Pig	Sheep/Goat	Dog	Aurochs	Boar	Red deer	Fallow Deer	Roe Deer	Fox	Badger	Bear	Hare	Hedgehog	Tortoise	Total
Unburnt (MaxAU)	1239	1294	7344	27	21	26	8	24	39	31	0	2	32	4	7	10098
Burnt (MaxAU)	91	88	369	0	0	1	0	2	2	6	2	0	4	0	0	565
Burnt %	6.8	6.4	4.8	0.0	0.0	3.7	0.0	7.7	4.9	16.2	100.0	0.0	11.1	0.0	0.0	5.3
Total (MaxAU)	1330	1382	7713	27	21	27	8	26	41	37	2	2	36	4	7	10663
χ^2	χ^2 13.595, p = .001															

Table 10. Incidence of burning by taxon (excluding neonatal specimens)

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

	Pit							
	2	7	11	18	24	42	48	51
Unburnt (MaxAU)	454	589	405	1103	1024	422	484	376
Burnt (MaxAU)	80	67	20	55	47	38	14	18
Burnt %	15.0	10.2	4.7	4.7	4.4	8.3	2.8	4.6
Total (MaxAU)	534	656	425	1158	1071	460	498	394
χ^2	χ^2 109.564, p = .000							

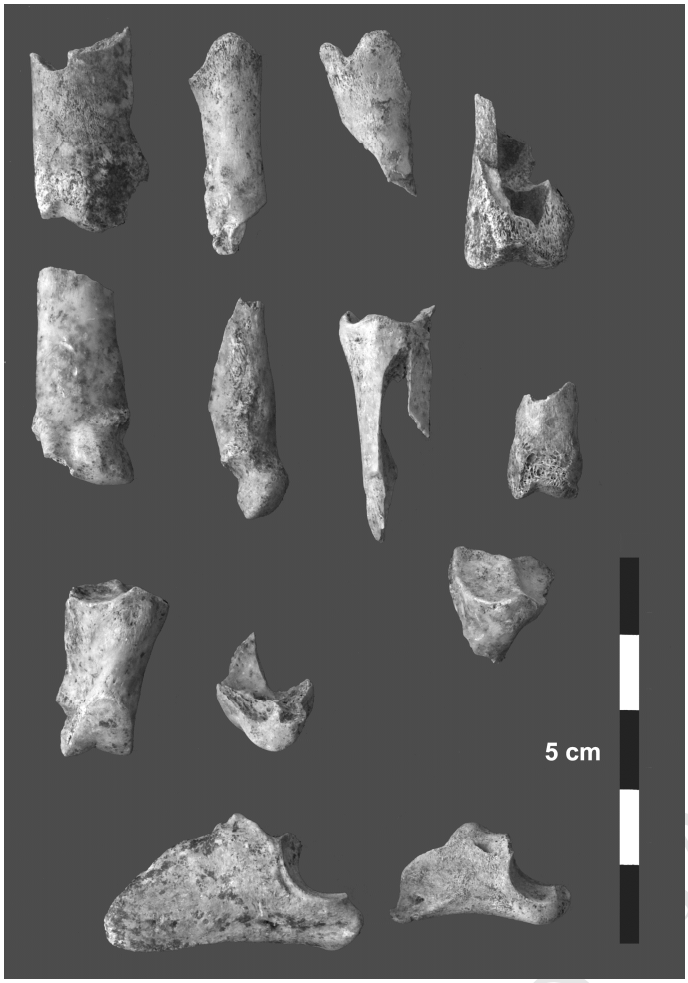
Table 11. Incidence of burning by taxon (excluding neonatal specimens) in eight faunally richest contexts

ACCEPTED MANUSCRIPT

		Cattle	Pig	Sheep/ Goat	Total	χ^2
MD	Unburnt (MaxAU)	67	102	450	619	
	Burnt (MaxAU)	5	17	8	30	χ^2 34.676, p = .000
	% Burnt	6.9	14.3	1.7	4.6	
SC	Unburnt (MaxAU)	40	45	234	319	
	Burnt (MaxAU)	2	5	7	14	χ^2 5.213, p = .074
	% Burnt	4.8	10.0	2.9	4.2	
Hp	Unburnt (MaxAU)	78	81	438	597	
	Burnt (MaxAU)	6	4	17	27	χ^2 2.022, p = .364
	% Burnt	7.1	4.7	3.7	4.3	
Hd	Unburnt (MaxAU)	86	125	603	814	
	Burnt (MaxAU)	5	11	31	47	χ^2 2.220, p = .330
	% Burnt	5.5	8.1	4.9	5.5	
Rp	Unburnt (MaxAU)	71	79	624	774	
	Burnt (MaxAU)	2	6	32	40	χ^2 1.577, p = .454
	% Burnt	2.7	7.1	4.9	4.9	
Up	Unburnt (MaxAU)	35	50	145	230	
	Burnt (MaxAU)	0	6	11	17	χ^2 3.877, p = .144
	% Burnt	0.0	10.7	7.1	6.9	
Rd	Unburnt (MaxAU)	51	62	393	506	
	Burnt (MaxAU)	1	3	14	18	χ^2 .631, p = .729
	% Burnt	1.9	4.6	3.4	3.4	
MCp	Unburnt (MaxAU)	31	38	423	492	
	Burnt (MaxAU)	11	2	17	30	χ^2 35.328, p = .000
	% Burnt	26.2	5.0	3.9	5.7	
MCd	Unburnt (MaxAU)	47	29	326	402	
	Burnt (MaxAU)	3	2	21	26	χ^2 .009, p = .996
	% Burnt	6.0	6.5	6.1	6.1	
PE	Unburnt (MaxAU)	46	38	381	465	
	Burnt (MaxAU)	2	2	23	27	χ^2 .213, p = .899
	% Burnt	4.2	5.0	5.7	5.5	
Fp	Unburnt (MaxAU)	55	118	339	512	
	Burnt (MaxAU)	7	5	23	35	χ^2 3.597, p = .166
	% Burnt	11.3	4.1	6.4	6.4	
Fd	Unburnt (MaxAU)	89	131	460	680	
	Burnt (MaxAU)	4	3	24	31	χ^2 1.863, p = .394
	% Burnt	4.3	2.2	5.0	4.4	
Tp	Unburnt (MaxAU)	103	119	428	650	
	Burnt (MaxAU)	3	9	38	50	χ^2 3.694, p = .158
	% Burnt	2.8	7.0	8.2	7.1	
Td	Unburnt (MaxAU)	63	68	372	503	
	Burnt (MaxAU)	6	4	30	40	χ^2 .530, p = .767
	% Burnt	8.7	5.6	7.5	7.4	
A	Unburnt (MaxAU)	27	13	138	178	
	Burnt (MaxAU)	7	3	9	19	χ^2 8.287, p = .016
	% Burnt	20.6	18.8	6.1	9.6	
C	Unburnt (MaxAU)	37	29	134	200	
	Burnt (MaxAU)	1	2	3	6	χ^2 1.637, p = .441
	% Burnt	2.6	6.5	2.2	2.9	
MTp	Unburnt (MaxAU)	72	27	593	692	
	Burnt (MaxAU)	9	0	35	44	χ^2 5.697, p = .058
	% Burnt	11.1	0.0	5.6	6.0	
MTd	Unburnt (MaxAU)	56	21	418	495	
	Burnt (MaxAU)	8	0	17	25	χ^2 10.105, p = .006
	% Burnt	12.5	0.0	3.9	4.8	
PH1	Unburnt (MaxAU)	69	47	300	416	
	Burnt (MaxAU)	4	0	4	8	χ^2 6.529, p = .038
	% Burnt	5.5	0.0	1.3	1.9	
PH2	Unburnt (MaxAU)	62	23	72	157	
	Burnt (MaxAU)	2	1	2	5	χ^2 .130, p = .937
	% Burnt	3.1	4.2	2.7	3.1	
PH3	Unburnt (MaxAU)	47	14	43	104	
	Burnt (MaxAU)	2	1	0	3	χ^2 2.355, p = .308
	% Burnt	4.1	6.7	0.0	2.8	

Table 12. Incidence of burning by body part in common domestic taxa (excluding neonatal specimens)

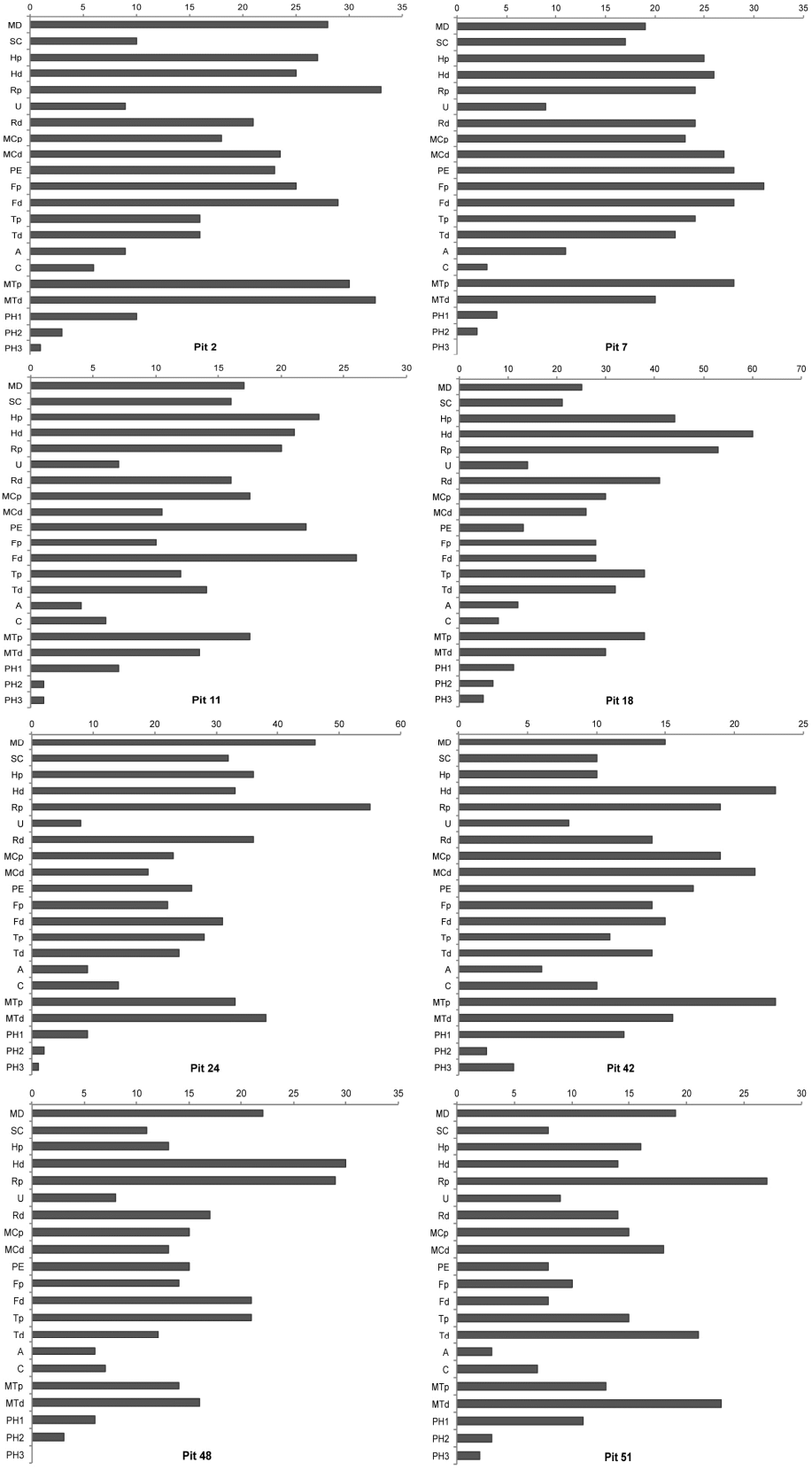
ACCEPTED MANUSCRIPT

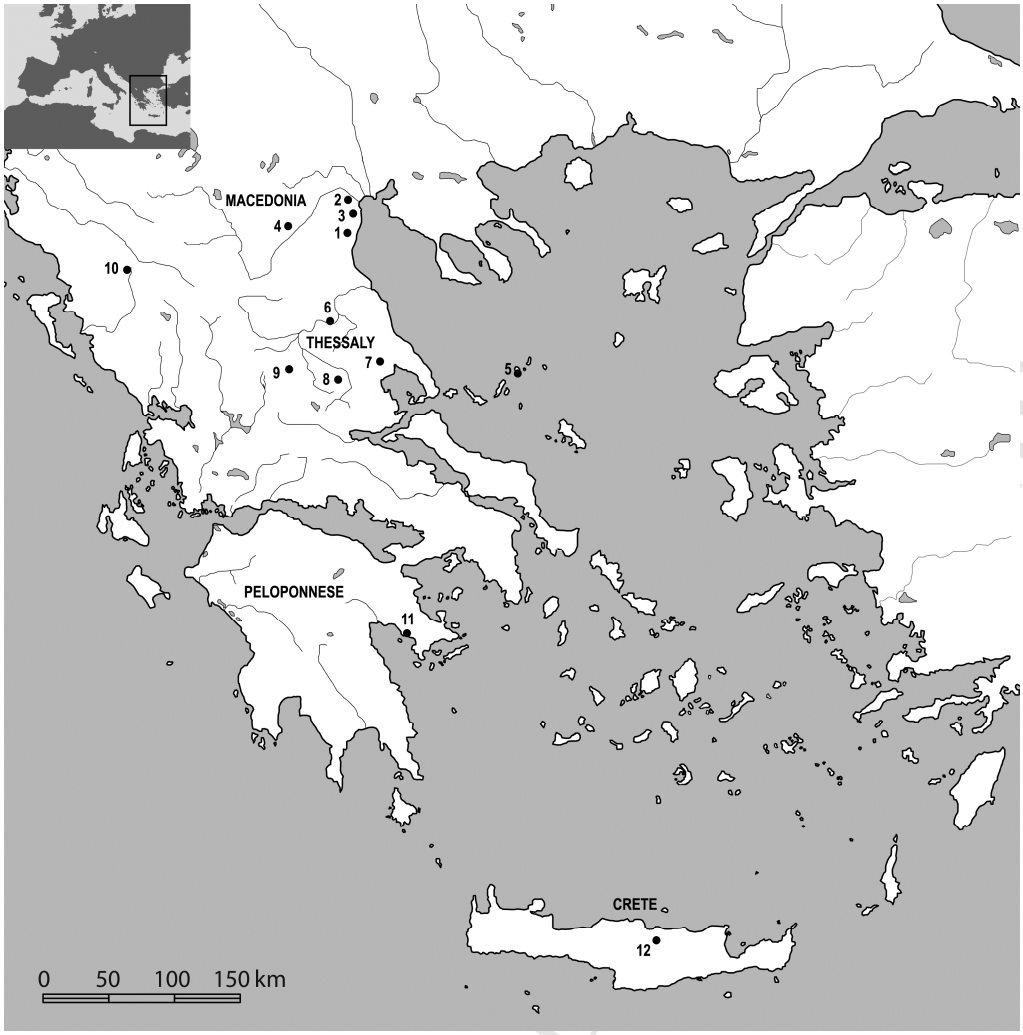


ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

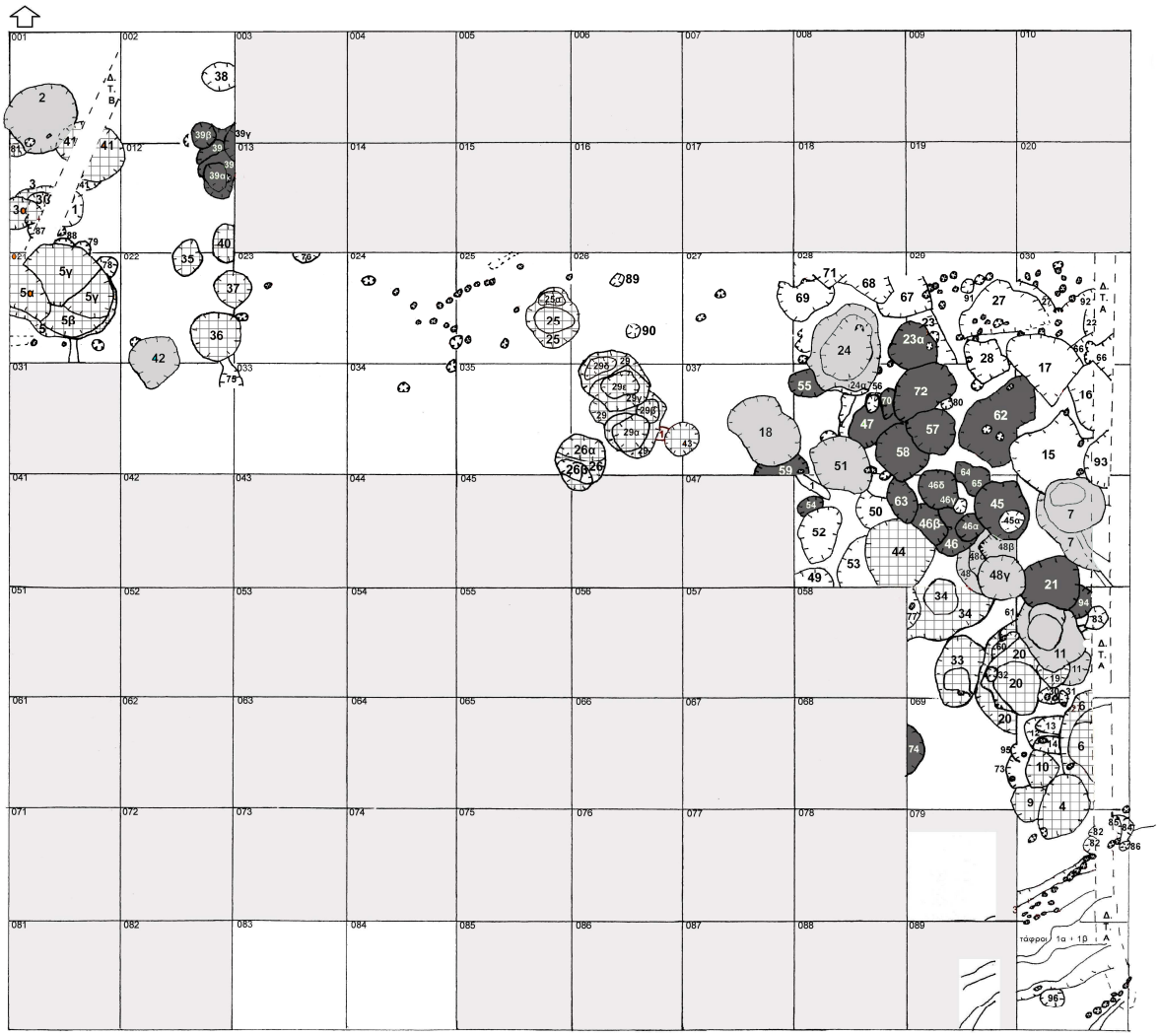
ACCEPTED MANUSCRIPT





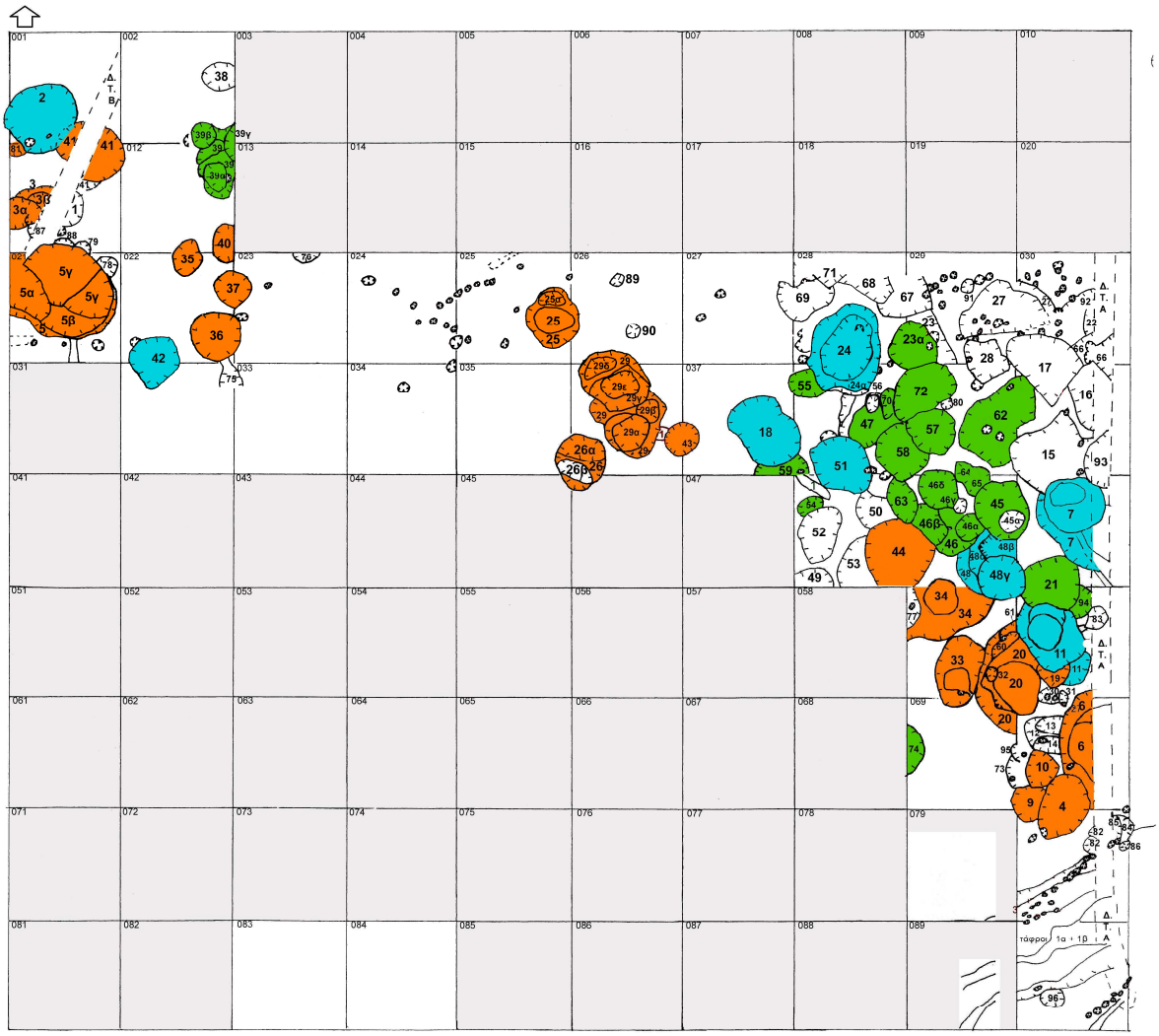
ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT



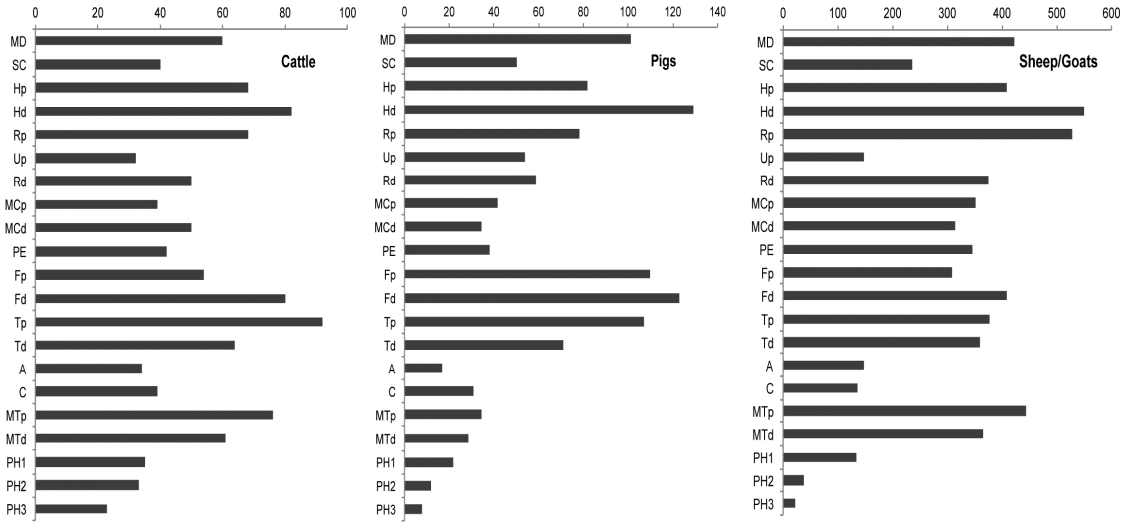
ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT



ACCEPTED

ACCEPTED MANUSCRIPT



ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

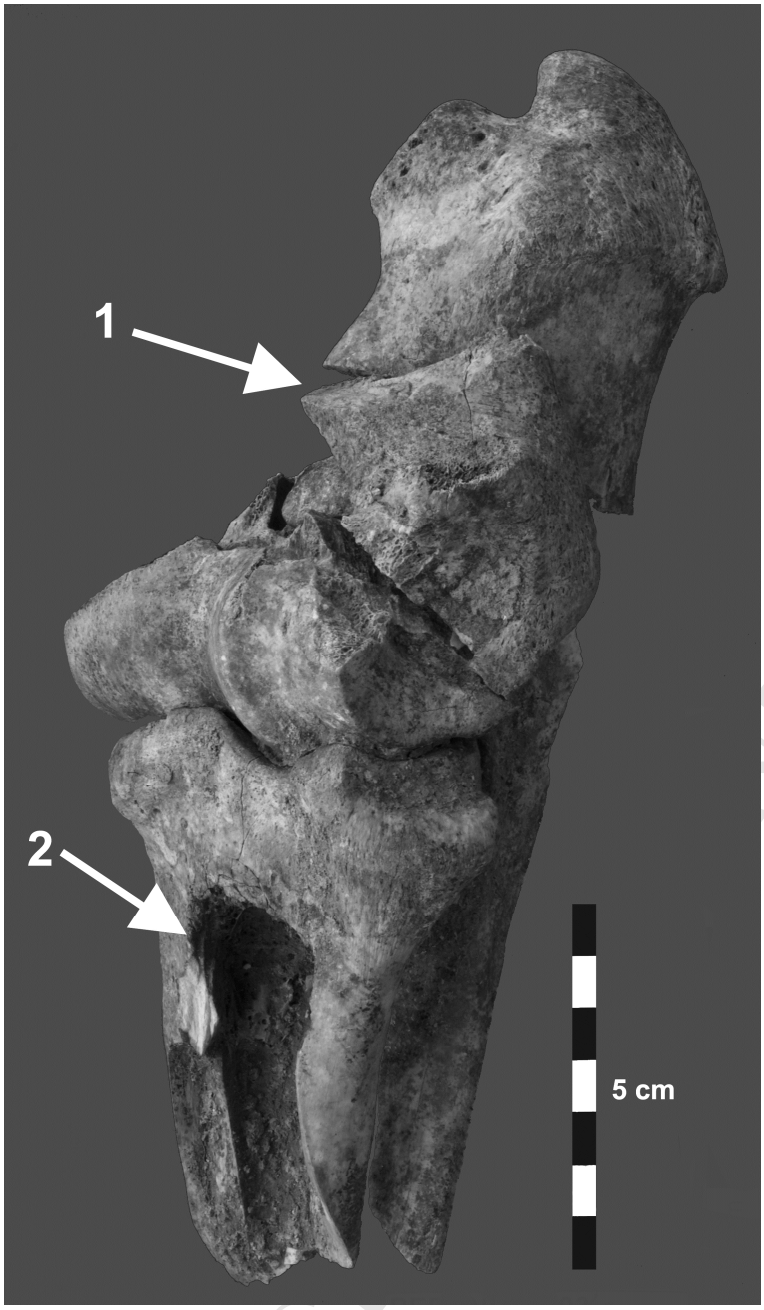
ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

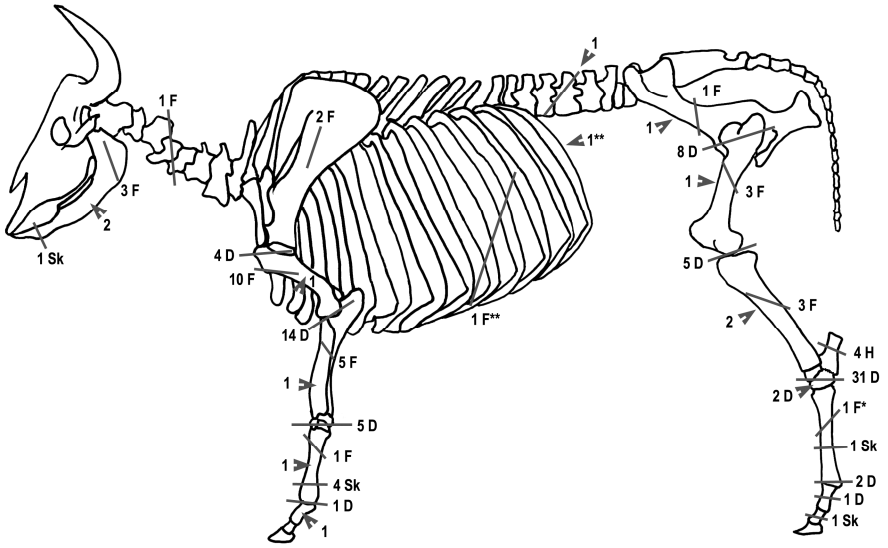
ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

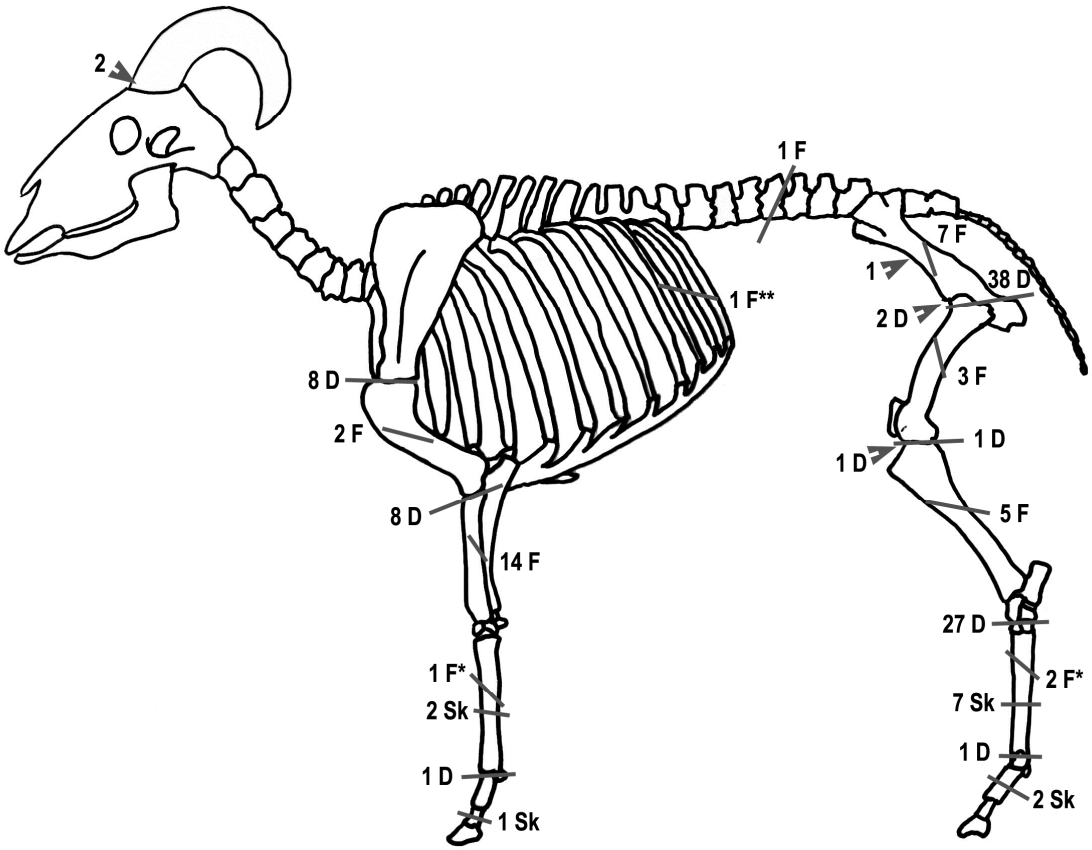
ACCEPTED MANUSCRIPT



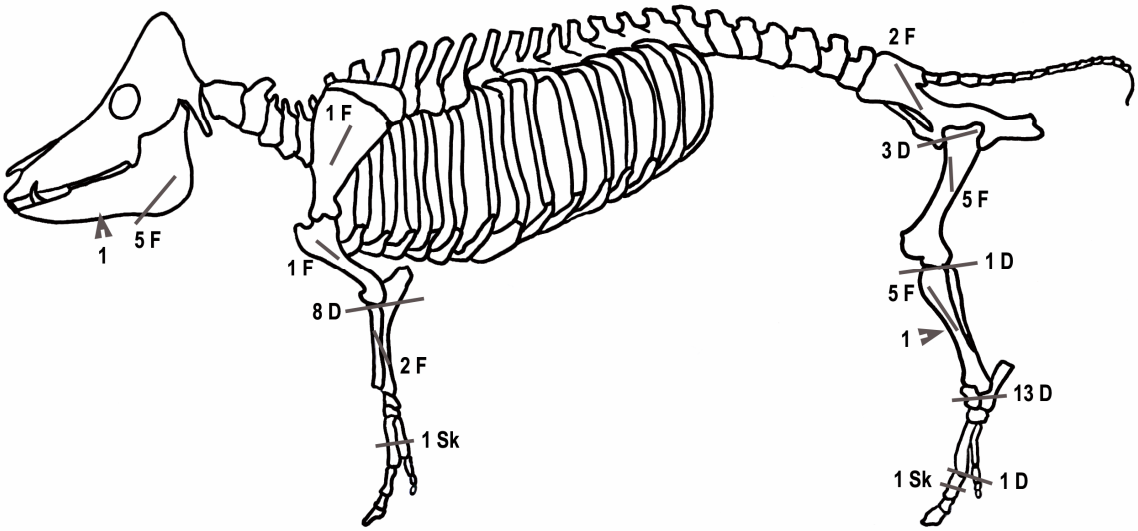
ACCEPTED MANUSCRIPT



ACCEPTED MANUSCRIPT


2
1 F
7 F
1
38 D
2 D
1 F**
3 F
8 D
2 F
1 D
1 D
5 F
8 D
14 F
27 D
1 F*
2 F*
2 Sk
7 Sk
1 D
1 D
2 Sk
1 Sk

ACCEPTED



ACCEPTED MANUSCRIPT