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NUMBER 2

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BREATHING LIFE INTO FOSSILS:

Taphonomic Studies in Honor of C.K. (Bob) Brain

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COVER CAPTIONS AND CREDITS.

Front cover, clockwise from top left.

Top left:
Artist's reconstruction of the depositional context of Swartkrans Cave, South Africa, with a leopard consuming a hominid carcass in a tree outside the cave: bones would subsequently wash into the cave and be incorporated in the breccia deposits. © 1985 Jay H. Matternes.

Top right: The Swartkrans cave deposits in South Africa, where excavations have yielded many hominids and other animal fossils. ©1985 David L. Brill.

Bottom right: Reconstruction of a hominid being carried by a leopard. © 1985 Jay H. Matternes.

Bottom left: Photograph of a leopard mandible and the skull cap of a hominid from Swartkrans, with the leopard's canines juxtaposed with puncture marks likely produced by a leopard carrying its hominid prey. © 1985 David L. Brill.

Center: Photo of Bob Brain holding a cast of a spotted hyena skull signed by all of the taphonomy conference participants. © 2004 Kathy Schick, Stone Age Institute.

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CHAPTER 13

CARCASS FORAGING BY EARLY HOMINIDS AT SWARTKRANS CAVE (SOUTH AFRICA): A NEW INVESTIGATION OF THE ZOOARCHAEOLOGY AND TAPHONOMY OF MEMBER 3

TRAVIS RAYNE PICKERING, MANUEL DOMÍNGUEZ-RODRIGO, CHARLES P. EGELAND AND C.K. BRAIN

ABSTRACT

While the Plio-Pleistocene paleontology of South African cave faunas is abundant and well-known, the zooarchaeology of these same assemblages is sparser and less appreciated. Most reconstructions of carcass foraging by Early Stone Age hominids are based largely on East African datasets. Here we take steps to remedy that situation by providing zooarchaeological and taphonomic data on the important *c*. 1.8 – 1.0 million year old archaeofauna from Swartkrans Member 3. Because most actualistic models of the interaction between hominids and carnivores over prey carcasses are focused on limb bones, we concentrated our study on the limb bone midshaft sub-assemblage from Member 3. Results indicate that tooth-marked specimens are approximately three and a half times as common as hominid-modified specimens in the limb bone shaft subassemblage as a whole. However, when taking into account diagenetic breakage, cortical surface preservation and differential fragmentation, hominids and carnivores seem to have contributed similarly to the formation of the Member 3 limb bone shaft subassemblage. Based on the anatomical distribution of stone tool cutmarks, Swartkrans hominids appear to have been capable carcass foragers during Member 3 times, gaining access to muscled carcass parts that are usually defleshed early and entirely by feeding carnivores. A similar pattern of cutmark distribution also characterizes broadly contemporary assemblages from East Africa, suggesting that hominids throughout the continent were capable acquirers of preferred parts from large animal carcasses.

INTRODUCTION

Several specific models of subsistence behavior and sociality in Plio-Pleistocene hominids have been presented in the past 25 years (reviewed most recently in, Domínguez-Rodrigo, 2002; Domínguez-Rodrigo and Pickering, 2003; Pickering and Domínguez-Rodrigo, in press). We believe that most of those models fall into one of two major groups. The first of these asserts that hominids regularly acquired whole or substantial portions of large mammal carcasses that they then transported to favored locales to process, consume and possibly share with others group members (e.g., Bunn, 1981, 1982, 1983, 1986, 1991: Bunn and Ezzo, 1993; Bunn and Kroll; 1986; Isaac, 1978, 1981a,b, 1983, 1984). These models, which indicate early access to carcasses by hominids, also imply by extension that hunting and/or aggressive scavenging was a prominent feature of their carcass-foraging repertoire. In contrast, the second group of models posits very limited access to fleshed carcasses by hominids (e.g., Binford, 1981, 1985, 1988; Blumenschine, 1986, 1987, 1988, 1991, 1995; Blumenschine et al., 1994). According to this view, even those carcass parts that hominids infrequently secured were already picked-over by carnivores, leaving no appreciable "surplus" resources for hominid scavengers to share.

The vigorous debate that has emerged between advocates of these competing views is particularly fascinating when one considers that the relevant faunal database derives largely from just one archaeological site, FLK 22 *Zinjanthropus* (FLK *Zinj*), Olduvai Gorge, Tanzania (*c*. 1.75 million years old [Ma]). It is true that data from

other important sites at Olduvai Gorge (site BK, *c*. 1.2 Ma), Peninj, Tanzania (the ST site complex, *c*. 1.5 Ma), and Koobi Fora, Kenya (various sites *c*. 1.88 – 1.6 Ma, but in particular, FxJj 50) have entered the debate (e.g., Bunn, 1994, 1997; Bunn et al., 1980; Domínguez-Rodrigo et al., 2002; Monahan, 1996), but more tangentially than those from FLK *Zinj*. At the very least, it can be said there is a geographic bias (i.e., the East African Rift Valley) in this dataset, with important information available from comparably aged South African sites rarely incorporated into overviews of the topic (for exceptions, see Pickering and Domínguez-Rodrigo, in press; Egeland et al., 2004). In addition to some socio-historical reasons for this bias (e.g., the *perception* that South African cave sites only inform about how early hominids died and not how they lived; the world community's relegation of South African science during the apartheid years), we also believe there several scientifically legitimate reasons for it.

First, the combination of topographic placement, unique ecological context and geomorphological form of South African hominid caves resulted in non-hominid "taphonomic overprints" on their faunas that are sometimes more complex than those from East African sites (e.g., Brain, 1981). Related to this point is the fact that all of the numerous actualistic models constructed since the 1980s to investigate early hominid foraging have been formulated in and with regard to the formation of open air sites in savanna mosaic habitats. Last, aside from purported bone tools from Sterkfontein, Swartkrans and Drimolen (Robinson, 1959; Brain and Shipman, 1993; Keyser, 2000) and indications of hominid-controlled fire from Swartkrans (Brain and Sillen, 1988), there is a paucity of evidence for other types of hominid-imparted bone modification reported for relevant South African sites. Until the results presented here, a *total* of only 15 cutmarked bone specimens (one from Sterkfontein, Pickering, 1999, and 14 from Swartkrans, Brain, 1993) and three chopmarked pieces (one from Sterkfontein, Brain, 1981, and two from Swartkrans, Brain, 1993) had been reported from the whole of Plio-Pleistocene South Africa.

In an effort to remedy this situation, we report here on 163 limb bone specimens from Swartkrans Member 3 with newly identified cutmarks and hammerstone percussion damage, and discuss the implications of these findings for the reconstruction of early hominid behavior in the Sterkfontein Valley, and beyond, *c*. 1.8 – 1.0 Ma. Our findings now rank the Swartkrans Member 3 archaeofauna as second only to FLK *Zinj* in number of hominid-modified bones from the Plio-Pleistocene and thus asserts the importance of this assemblage and the South African zooarchaeological record in general discussions of early hominid carcass foraging.

Materials and Methods

A systematic zooarchaeological analysis of the complete limb bone shaft fragment subassemblage from Swartkrans Member 3 (1979 – 1986 excavations) was conducted. This 12,505 (number of identified specimens, NISP) piece sample derives from the larger 108,098 NISP fossil assemblage described initially by Brain (1993), Watson (1993) and Newman (1993) and also encompasses the subset of limb bone shaft specimens reported by Bishop and Blumenschine (1994). Limb bone shaft fragments were chosen as the analytical sample because most current actualistic models of hominid carcass use focus in large part on limb elements (e.g., Blumenschine, 1988, 1995; Blumenschine and Marean, 1995; Blumenschine and Selvaggio, 1991; Capaldo, 1995, 1997, 1998; Cleghorn and Marean, 2004 and this volume; Domínguez-Rodrigo, 1999a, 1999b, 2001; Marean and Cleghorn, 2003; Marean et al., 1992, 2004; Pickering et al., 2003; Selvaggio, 1994, 1998; Selvaggio and Wilder, 2001). Limb bone shaft specimens are defined here as pieces from ungulate humeri, radioulnae, metacarpals, femora, tibiae and metatarsals that preserve less than their complete, original diaphyseal circumferences and do not possess their articular ends (modified from Pickering, 1999; see also Pickering et al., 2003, 2005).

We isolated two sub-samples from the complete limb bone subassemblage for more in-depth analysis. Analytical Set I is comprised of every specimen ≥5 cm in maximum dimension plus every specimen <5 cm in maximum dimension that also preserves prehistoric bone surface modifications. This analytical set, with a NISP of 1466, is "unadjusted." In other words, it is not comparable to modern, actualistically derived samples of human butchered and carnivore ravaged bones (see discussion below), but it does provide "maximum" information on the frequency and distribution of hominid and carnivore bone surface modifications.

In addition to Analytical Set I, we created an adjusted sample, Analytical Set II, which is more comparable to actualistic samples that model the carcass-focused interactions of hominids and carnivores (see also, Blumenschine, 1995: 28, 33-39). Analytical Set II was assembled by beginning with the original limb bone subassemblage of 12,505 pieces and then taking the following steps. First, because the experimental control samples (i.e., Blumenschine, 1988, 1995; Blumenschine and Selvaggio, 1988; Capaldo, 1995, 1997, 1998; Selvaggio, 1994, 1998) do not consider specimens <2 cm in maximum dimension, specimens in the Member 3 fossil assemblage <2 cm were eliminated from consideration for comparative analyses—even if they bear prehistoric bone surface modifications. This resulted in a modified NISP of 8352. Second, processes of diagenetic fragmentation and cortical surface degradation not operant in the modern control samples had to be controlled in the fossil assemblage. Because of the assemblage's large size and time constraints, we were forced to adjust for these factors through a sampling procedure, rather than examining every specimen. This procedure is summarized thusly:

1. First, we sampled randomly 1,009 specimens from three size-range categories (2 – 3 cm, 3 – 4 cm, 4 – 5 cm).
2. Within each size-range category, we calculated the percentage of specimens with good cortical surface preservation and green versus dry breakage planes.[1]
3. We then averaged these percentages, which resulted in an average of 48.3 % of specimens <5 cm displaying good surface preservation and 65.0 % with dry breakage.
4. Next we applied these percentages from the sample back to the starting NISP of 8,352. Starting with the projection of well-preserved specimens, this is 8,352 × 0.483 = 4,034.
5. Adjusting for dry breakage was accomplished by multiplying 4,034 by the projected percentage of dry-broken specimens (4,034 × 0.65 = 2,622).
6. In order to reach a NISP estimate adjusted for green breakage, however, we first considered that the dry-broken NISP (2,622) is inflated by the fact that each originally deposited bone was broken into at least two pieces, at least doubling the dry-broken NISP. Thus, the most conservative approach divides the dry-broken NISP by two (2,622/2 = 1311). That estimate was then added to the green broken NISP (4,034 × 0.35 = 1,412), resulting in a new NISP of 2,723 of well-preserved and green-broken pieces.
7. Because all specimens in Analytical Set I (Member 3 NISP = 1,466) were coded individually for surface preservation and breakage, there was no need to following the sampling procedure outline in steps 1–6. Instead, we simply added the adjusted non-Analytical Set I NISP from above (2,723) to the adjusted Analytical Set I data to obtain a total adjusted NISP for Analytical Set II. From Analytical Set I there are 428 specimens >2 cm that display good cortical surfaces and green breaks. The resulting grand total of well-preserved, green-broken specimens is thus 3,151 (2,723 + 428), the final NISP for the Member 3 Analytical Set II.

We collected data on the following zooarchaeological and taphonomic attributes in both analytical sets.

Skeletal element and element portion

When possible, specimens were identified to skeletal element (humerus, radioulna, metacarpal, femur, tibia, metatarsal, metapodial). Using the system of Domínguez-Rodrigo (1997, 1999a; Barba Egido and Domínguez-Rodrigo, 2005), we were able to categorize many of those specimens not identifiable to a specific skeletal element to a limb segment, as an upper (humerus or femur), intermediate (radioulna or tibia) or lower (metapodials) limb fragment. Specimens that remained unidentified after these steps were then simply entered into the database as limb bone shaft fragments. In addition, due to time constraints, no specimen <5 cm was identified beyond the level of limb bone shaft fragment; however, it is worth noting that a significant portion of these fragments are probably identifiable to skeletal part and will be considered in future analyses. Finally, following Blumenschine's (1988) bone portion classification system and in order to facilitate comparisons with experimental control samples (e.g., Blumenschine, 1988, 1995; Capaldo, 1995, 1997; Selvaggio, 1994, 1998), every specimen >2 cm in maximum dimension (n = 8,352) was identified as a near-epiphyseal or midshaft fragment.

Animal body size

Each specimen was assigned to an animal body size group, following the size class system constructed for antelope by Brain (1974, 1981). For some analyses, individual body size groups were combined into three broad categories: small (corresponding to Brain's Size Class 1); medium (the combined remains of Size Classes 2 and 3); large (the combined remains of Size Class 4 and larger).

Maximum linear dimension

Maximum length of each specimen, irrespective of orientation, was measured to the nearest centimeter.

Circumference

In a modification of Bunn's (1983) system, the cross-sectional completeness of each specimen was recorded in increments of 25 %: <25 % of the original diaphyseal circumference preserved along a specimen's length; <50 % but >25 % of the original circumference preserved; <75 % but >50 % of the original circumference preserved; <100 % but >75 % of the original circumference preserved.

Fracture patterns

Recent experimental results indicate that combined

[1] For assessment of cortical surface preservation, each fossil specimen was assigned to a subaerial weathering stage (Behrensmeyer, 1978). In addition, our observations suggest that bone surface preservation on specimens from Member 3 was also affected by various diagenetic processes, including water action, manganese formation and soil leaching. Thus, to account for overall surface condition, a subjective score of poor, moderate or good was assigned to each specimen (e.g., Pickering, 1999; Pickering et al., 2000). This is a qualitative assessment used to convey the relative "fidelity" of current bone surfaces for continuing to preserve prehistoric bone surface modifications. Distinguishing green- from dry-broken fracture edges is relatively simple. Green fractures occur on bone before loss of its organic fraction and are associated with smooth release surfaces and possess fracture angles (i.e., the "angle formed by the fracture surface [of a broken bone and its] cortical surface" [Villa and Mahieu, 1991: 34]) <85° or >95° (Pickering et al., 2005). In contrast, dry fractures occur after loss of a bone's organic content and are characterized by fracture angles closer to 90°.

fracture plane and angle data are useful for sorting dynamic (e.g., hammerstone percussion) and static (e.g., carnivore chewing) loading events on green bones (i.e., bones without significant loss of their organic fractions and desiccation) at the assemblage level (Alcántara Gracía et al., in press; see also Capaldo and Blumenschine, 1994; Pickering et al., 2005). Thus, we conducted a detailed analysis of these features on all green fractures in the Member 3 assemblage (diagenetic and other "dry" break surfaces were ignored). Each green fracture plane ≥5 cm in length was recorded in relation to the long axis of the specimen: longitudinal (parallel) to the long axis, transverse (perpendicular) to the long axis or oblique (diagonal) to the long axis. Midpoint angles of those fracture planes were then measured to the nearest degree using a goniometer (Pickering et al., 2005).

Bone surface modifications

Identification of bone surface modifications was undertaken using criteria and methods reviewed by Blumenschine et al. (1996). Each specimen was inspected under a strong oblique light source with the aid of at least 10 x magnification, as recommended by several analysts (e.g., Bunn, 1981, 1991; Bunn and Kroll, 1986; Blumenschine, 1995; Blumenschine and Marean, 1993; Blumenschine and Selvaggio, 1988, 1991; Blumenschine et al., 1996). During examination of each specimen, the bone surface was continuously repositioned in relation to the light source in order to discern modifications of any appreciable depth. Although other classes of bone surface modification (e.g., "random" striae, rodent gnaw marks, burning, alteration by gastric acids) were observed and noted, only carnivore tooth marks, stone tool cutmarks and hammerstone percussion marks were searched for and recorded systematically.

Several researchers have stressed the potential of various abiotic processes to mimic hominid-imparted bone surface damage, complicating inferential associations of particular marks and hominid butchery activity (e.g., Behrensmeyer et al., 1986, 1989; Fiorillo, 1989; Potts and Shipman, 1981; Oliver, 1989; Shipman and Rose, 1983). Thus, *all* specimens asserted to preserve hominid-imparted damage were subsequently examined by each researcher, and only after an unanimous decision was a specimen accepted and recorded as preserving the appropriate surface modification. Although time-consuming, this procedure was ultimately necessary for secure determinations. A prominent presence of abiotically derived linear striae (sometimes closely resembling stone tool cutmarks) was indicated by our many hours of experience with the curated collection and corroborated by observations of the sedimentary matrix from which the assemblage derives. As illustrated in Figure 1, the Member 3 deposit is a complex karstic coluvium, consisting

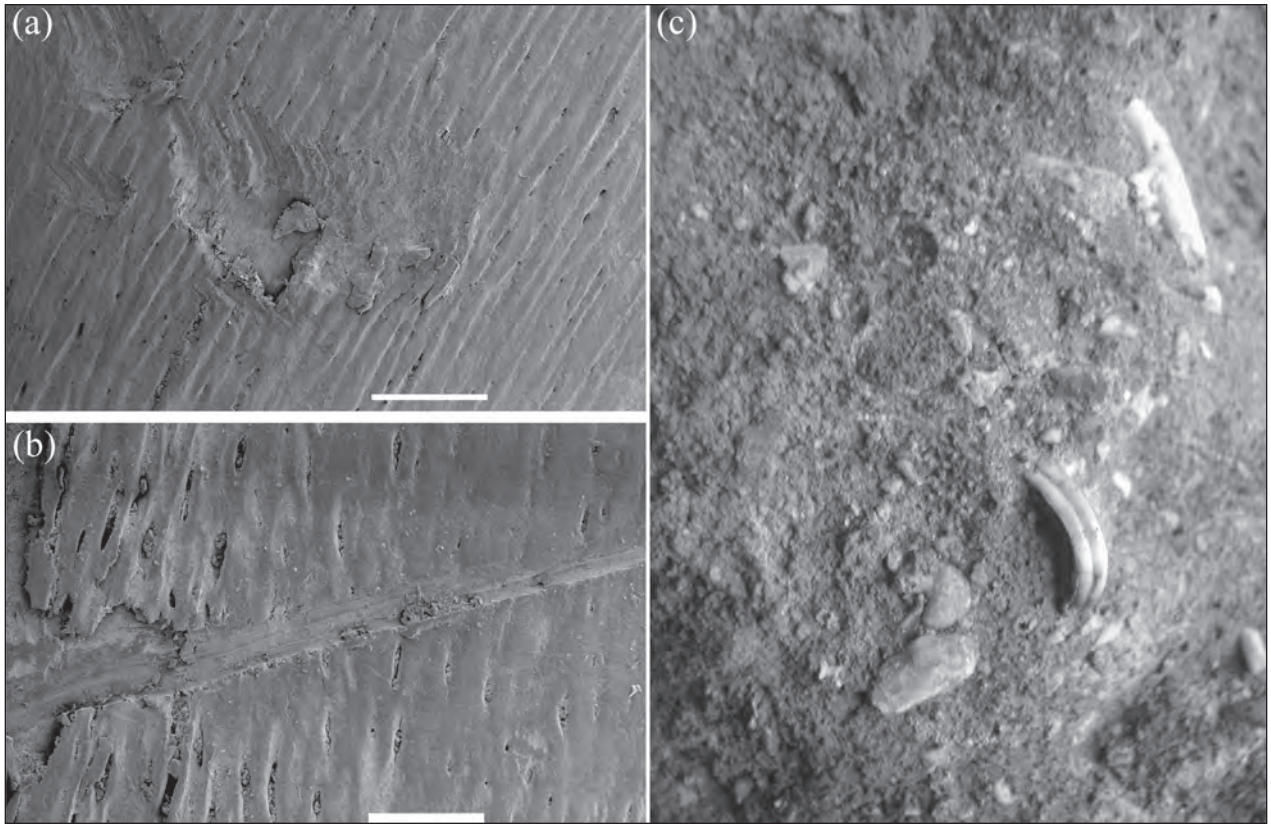

Figure 1. Scanning electron microscope micrographs showing representative examples of hammerstone percussion marks (including pits and emanating patches of striae) (a) and a cutmark (with internal microstriations)(b). The other image (c) shows a close-up of in situ *Member 3 sediment, which includes large angular clasts that held the potential to impart cutmark mimics on bone specimens.*

of materials ranging from clays to large angular clasts, which certainly held the potential to create abundant polish, abrasion and cutmark mimics on the Member 3 fossils. Thus, a configurational approach to cutmark identification, in which we considered anatomical placement as well as mark morphology, was absolutely necessary in this archaeofauna (see Binford, 1981; Domínguez-Rodrigo et al. 2005; Pickering et al., 2000).

Results and discussion

Skeletal element and taxonomic representation

Skeletal part representation of the Member 3 limb bone shaft assemblage is summarized by animal body size group in Table 1. At least two results emerge from consideration of these data that are generally relevant to the analysis of limb bone shaft specimens in zooarchaeology. While these are not the focus of this paper, we want to mention them and note that we are currently investigating them experimentally.

As is apparent from Table 2, identification of limb bone shaft specimens to specific element was accomplished most successfully for the remains of medium-sized animals (Size Classes 2 and 3), followed next by large animal specimens (Size Class 4 and larger) and last by small animal specimens (Size Class 1). The difference in proportion of specimens identified to skeletal element is statistically significant between Size Classes 1 and 2 (X^2 = 51.238, 1 d.f., p<0.001) and between Size Classes 1 and 3 (X^2 = 52.867, 1 d.f., p<0.001), but not between Size Classes 2 and 4 and larger (X^2 = 0.502, 1.d.f., p<0.5) or Size Classes 3 and 4 and larger (X^2 = 1.068, 1 d.f., p<0.5). Further, the differences between Size Classes 1 and 4 and larger are statistically significant (X^2 = 17.276, 1 d.f., p<0.001), while those between Size Classes 2 and 3 are not (X^2 = 0.616, 1 d.f., p<0.5). The lesser potential of shaft fragments from small ungulates to be identified to specific element is probably due to the absolutely smaller size of the preserved bone fragments from these diminutive animals.

Although shaft fragments from large-sized animals are only minimally less identifiable (i.e., statistically non-significant) than those from medium-sized animals, we noted that much more effort, time and consultation among analysts was involved in the assignment of large animal specimens to skeletal element than that for specimens from medium-sized animals. We hypothesize that this difference is at least in part because more of the total surface area of an absolutely larger bone is "featureless" than is that of an absolutely smaller bone. Thus, we

Table 1. Skeletal element representation of Swartkrans Member 3 limb bone shaft fragments (number of identified specimens, NISP)[1]

	SMALL	MEDIUM		LARGE	
Skeletal element	Size Class 1	Size Class 2	Size Class 3	Size Class 4	Size Class 5
Humerus	7	42	35	11	
Radioulna	13	32	20	5	
Metacarpal	14	22	15	4	
Femur	15	54	28	12	
Tibia	27	120	85	17	1
Metatarsal	12	44	31	5	
Metapodial	19	59	55	20	
Upper	23	30	24	9	
Intermediate	17	47	14	5	
Limb bone shaft fragment	152	124	66	16	1
Total	299	574	373	104	2

1. Animal size classes are based on Brain's (1981) well-known system for antelope. Three separate categorizations of specimen identification are provided: (1) those specimens that could be identified to a specific element (above the third horizontal line); (2) those specimens that could be identified to a limb segment, as an upper (humerus or femur) or intermediate (radioulna or tibia) specimen but no further (between the third and fourth horizontal lines); (3) those specimens that could be identified as limb bone shaft fragments only (between the fourth and fifth horizontal lines). No lower limb bone specimens are listed in the second category, because they (by definition; see Domínguez-Rodrigo, 1997, 1999a) can be assigned more specifically as metapodials.

Table 2. Relative identifiability of Swartkrans Member 3 limb bone shaft fragments in different animal body size groups[1]

Size Class	Number identified to specific element	Number identified to limb segment only	Number identified to limb bone shaft only	Total
1	88 (*29.4* %)	59 (*19.7* %)	152 (*50.8* %)	299 (*100.0* %)
2	314 (*54.6* %)	136 (*23.7* %)	124 (*21.6* %)	574 (*100.0* %)
3	214 (*57.4*%)	93 (*24.9* %)	66 (*17.6* %)	373 (*100.0* %)
4 and 5	55 (*51.9* %)	34 (*32.1* %)	17 (*16.0* %)	106 (*100.0* %)
Total	671 (*49.6* %)	322 (*23.8* %)	359 (*26.6* %)	1352 (*100.0* %)

1. Animal size classes are based on Brain's (1981) well-known system for antelope; in this study, Size Class 1 are considered small-sized animals, Size Classes 2 and 3 are considered medium-sized animals and Size Class 4 and larger are considered large animals. The second column lists the number of identified specimens (NISP) identified as humeri, radioulnae, metacarpals, femora, tibiae and metatarsals in each body size class. The third column lists the NISP for those fragments identified as upper limb pieces (humerus or femur), intermediate limb pieces (radioulna or tibia) or metapodial pieces. The fourth column lists the NISP for those fragments identified only as limb bone shaft pieces.

predict that when a large-sized animal limb bone and a medium-sized animal limb bone are each comminuted heavily and equivalently, any given fragment of the large animal bone is less likely to preserve a landmark, or part thereof, useful for skeletal part identification than is any given fragment from the small animal bone. In addition, our observations indicate that any given shaft fragment from a large bone is more likely to be relatively "straight" (i.e., without clear indication of extrapolated cross-sectional shape and incipient curvature) than that of a fragment from a smaller bone. This is pertinent because cross-sectional shape and curvature are element-specific and thus useful features for distinguishing different limb bones.

The second point relevant to identification analysis in limb bone shaft studies concerns the high proportion of hindlimb specimens that we identified to specific skeletal element relative to forelimb specimens (Table 3). More particularly, the tibia possesses the highest NISP values of any specific limb bone across all body size classes. Femur NISP counts are ranked second in three of four cases. In contrast, radioulna NISP counts are second-to-last in rank in three of four cases and metacarpals score last in three of four cases. Perusal of some other well-known Pleistocene archaeofaunas reveals a similar pattern of tibia-highest representation, based on NISP and minimum number of elements (MNE) at FLK *Zinj* and FLKN levels 1 – 2 (Olduvai, Tanzania) (Bunn, 1986; Bunn and Kroll, 1986) and Kobeh Cave (Iran) (Marean and Kim, 1998), among other sites (Pickering et al., 2006). As we contend above that cross-sectional shape is the likely determining factor in the differential success of identifying small versus large animal limb shafts, our initial experimental results suggest the same for hindlimb versus forelimb elements (Pickering et al., 2006).

Bone surface modifications

Table 4 provides a summary of prehistoric bone surface modifications in the Member 3 limb bone shaft subassemblage (see also Appendix). These data, analyzed in

Table 3. Number of identified specimens (NISP) rank order for Swartkrans Member 3 limb bone shaft fragments identified to specific skeletal element[1]

Rank	Size Class 1	Size Class 2	Size Class 3	Size Class 4	Size Class 5
1	Tibia	Tibia	Tibia	Tibia	Tibia
2	Femur	Femur	Humerus	Femur	
3	Metacarpal	Metatarsal	Metatarsal	Humerus	
4	Radioulna	Humerus	Femur	Metatarsal	}Tied
5	Metatarsal	Radioulna	Radioulna	Radioulna	
6	Humerus	Metacarpal	Metacarpal	Metacarpal	

1. Animal size classes are based on Brain's (1981) well-known system for antelope.

combination with skeletal part data, can usefully inform about the relative contribution of hominids and large carnivores to the formation of the Member 3 fauna. In addition, consideration of the hominid-imparted modifications in isolation allows for specific inferences of the carcass-acquiring abilities of hominids.

Assessing the relative contribution of hominids and carnivores to assemblage formation

When the limb bone shaft subassemblage is viewed as a whole (NISP = 12,505), both hominid-modified specimens (n = 163; 1.3 % of the total NISP) and carnivore tooth-marked specimens (n = 532; 4.3 % of the total NISP) are present at very low frequencies. A majority of the hominid-modified specimens bear damage inferred to be indicative of hammerstone percussion: 53 specimens are classified as impact flakes and an additional 50 preserve percussion pits, striae and/or notches (Table 4; Appendix). Collectively, these percussion-created specimens account for just 0.8 % of the total limb bone subassemblage NISP. A smaller number of 60 specimens (0.5 % of the total limb bone subassemblage) preserve cutmarks (Pickering et al., 2004a) (Table 4; Appendix).

The role of hominids and carnivores in the formation of the Member 3 fauna can be characterized more specifically when the data are examined by Size Class (Table 4). Carnivores were clearly the most active modifiers of Size Class 1 carcasses; 73.6 % of Size Class 1 limb bone specimens exhibit tooth marks. Tooth pit dimensions implicate leopards as one likely modifier of these small carcasses (Pickering et al., 2004b). Although tooth-marked specimens continue to appear in higher frequencies than hominid-modified specimens on Size Class 2, 3 and 4 remains, they are tooth-marked in lower frequencies compared to specimens from Size Class 1 carcasses. This coincides with an increase in hominid damage within these larger Size Classes, particularly in the frequency of cutmarked specimens, suggesting that hominids were a more active, though certainly not major, collector of especially Size Class 2 and 3 carcasses (Figure 2). Finally, limb bone fracture patterns support the suggestion that carnivores played a more important role in bone accumulation relative to hominids; fracture angle data indicate that a significant portion of green breakage in the Member 3 fauna was initiated through static loading characteristic of carnivore feeding (Pickering et al., 2005).

In order to more accurately assess the relative contributions of hominids and carnivores in assemblage formation we examined the Member 3 data within a comparative framework based on actualistic datasets of known derivation. The Member 3 bone surface modification percentages fall far short of experimental standards for both human- and carnivore-processed limb bones. For example, Blumenschine (1995) found that in his "carnivore-only" experiments on average 83.9 % of limb bone specimens are tooth-marked. Blumenschine and Selvaggio (1988) report that ~30 % of the total specimens in their experimental sample of hammerstone-broken limb bones bear at least one percussion mark. Finally, ethnoarchaeological and experimental studies indicate that hominid tool-assisted defleshing results in 15 – 30% of specimens bearing cutmarks (Bunn, 1982; Domínguez-Rodrigo, 1997, 1999a; Lupo and O'Connell, 2002).

However, as discussed above in the **Materials and Methods**, we made several adjustments to the Swartkrans data in Analytical Set II that renders them more comparable to the actualistic data and changes the compared fossil NISP to 3,151. This adjustment to the compared NISP value slightly alters bone surface mark percentages. When controlled for diagenetic fragmentation and cortical surface preservation, the frequencies of hominid- and carnivore-modified specimens are broadly similar (Table 5).

Examination of Table 5 reveals that when compared to the actualistic controls even the adjusted values in Analytical Set II are inconsistent with scenarios of intense hominid or carnivore involvement in the formation of the Member 3 accumulation. This is not surprising considering the depositional nature and time depth of the Member 3 fauna: like most other South African cave assemblages, the Member 3 assemblage was formed, at least in part, by secondarily deposited material derived from the cave's surface catchment. Over long periods of time it is likely that abiotic processes in addition to biotic actors not dealt with systematically in this analysis (e.g., rodents) contributed significantly to assemblage formation. Regardless, the adjusted bone surface damage frequencies suggest that hominids and carnivores contributed similarly to assemblage formation. Differential fragmentation supports this contention. A higher proportion of carnivore-modified specimens is comprised of pieces <2 cm in maximum dimension (68/532 = 12.8 %) relative to hominid-modified specimens (4/163 = 2.5 %), indicating that carnivore-modified specimens are more heavily fragmented than their hominid-modified counterparts. As Bartram (1993) has pointed out, intense fragmentation can artificially increase bone modification values based on NISP, in this case carnivore-modified specimens relative to hominid-modified specimens. Only an expanded analysis of the remaining skeletal parts will tell whether this suggestion can be applied to the Member 3 fauna as a whole.

In summary, there are low frequencies of both hominid and carnivore damage in the Member 3 fauna. Stratifying the sample by Size Class reveals that carnivores were the major modifiers of Size Class 1 carcasses, while hominids played their most significant role in Size Class 2 and 3 carcass modification. Thus, the bone surface damage evidence presented in this study supplements Brain's (1993) earlier arguments by indicating an important hominid contribution to assemblage formation in Member 3 times.

Table 4. Summary of prehistoric bone surface modifications in the Swartkrans Member 3 limb bone shaft subassemblage[1]

Size Class	Skeletal element	NISP	Cutmarks	Percussion marks[2]	Tooth marks
1					
	Humerus	7	1 (14.2)		3 (42.9)
	Radioulna	13			7 (53.9)
	Metacarpal	14		3 (21.4)	9 (64.3)
	Femur	15		3 (20.0)	4 (26.7)
	Tibia	27	1 (3.7)	2 (7.4)	14 (51.9)
	Metatarsal	12	1 (8.3)		5 (41.7)
	Upper	23	1 (4.3)		22 (95.7)
	Intermediate	17			15 (88.2)
	Metapodial	19	1 (5.3)		15 (79.0)
	Limb bone shaft	152		2 (1.3)	127 (83.6)
	Total	299	5 (1.7)	9 (3.0)	217 (73.6)
2					
	Humerus	42	2 (4.8)	3 (7.1)	4 (9.5)
	Radioulna	32	2 (6.3)	3 (9.4)	5 (15.6)
	Metacarpal	22	2 (9.1)	2 (9.1)	10 (45.5)
	Femur	54	5 (9.3)	3 (5.7)	13 (24.5)
	Tibia	120	6 (5.0)	4 (3.3)	21 (17.5)
	Metatarsal	44	2 (4.6)	1 (2.3)	8 (18.2)
	Upper	30	4 (13.3)		14 (46.7)
	Intermediate	47	1 (2.1)		15 (32.6)
	Metapodial	59	2 (3.4)		14 (23.7)
	Limb bone shaft	124	6 (4.8)	4 (3.2)	22 (17.7)
	Total	573	32 (5.6)	20 (3.5)	126 (22.1)
3					
	Humerus	35	2 (5.7)	3 (8.6)	8 (22.9)
	Radioulna	20	2 (10.0)		6 (30.0)
	Metacarpal	15	1 (6.7)	1 (6.7)	4 (26.7)
	Femur	28	3 (10.7)	2 (7.1)	10 (35.7)
	Tibia	85	3 (3.5)	4 (4.7)	29 (34.1)
	Metatarsal	31	3 (9.7)	1 (3.2)	9 (29.0)
	Upper	24	3 (12.5)		7 (29.2)
	Intermediate	14			6 (42.9)
	Metapodial	55	1 (1.8)	1 (1.8)	17 (30.9)
	Limb bone shaft	66	1 (1.5)	1 (1.5)	20 (30.3)
	Total	373	19 (5.1)	13 (3.5)	116 (31.1)
4					
	Humerus	11	2 (18.2)		
	Radioulna	5	1 (20.0)		1 (20.0)
	Metacarpal	4		1 (25.0)	
	Femur	12			2 (16.7)
	Tibia	17			7 (41.2)
	Metatarsal	5			1 (20.0)
	Upper	9			
	Intermediate	5			
	Metapodial	20	1 (5.0)	2 (10.0)	1 (5.0)
	Limb bone shaft	16			
	Total	104	4 (3.9)	3 (2.9)	12 (11.5)

1. Animal size classes are based on Brain's (1981) well-known system for antelopes. Parenthetical values in the fourth through sixth columns are percentages of the total number of identified specimens (NISP) for any row. Indeterminately identified pieces are those specimens that could be identified to a limb segment, as an upper (humerus or femur) or intermediate (radioulna or tibia) specimen but no further.

2. Percussion marks = pits and striae, in some cases associated with impact notches. Five additional specimens preserve notches only and a separate total of 53 impact flake specimens have been recovered from Swartkrans Member 3.

Table 4. Summary of prehistoric bone surface modifications in the Swartkrans Member 3 limb bone shaft subassemblage (continued)[1]

Size Class	Skeletal element	NISP	Cutmarks	Percussion marks[2]	Tooth marks
1 – 4 (total)					
	Upper total	290	23 (8.0)	13 (4.5)	87 (30.0)
	Humerus	95	7 (7.4)	6 (6.3)	15 (15.8)
	Femur	109	8 (7.3)	7 (6.4)	29 (26.6)
	Indeterminate	86	8 (9.3)		43 (50.0)
	Intermediate total	402	16 (4.0)	13 (3.2)	126 (31.3)
	Radioulna	70	5 (7.1)	3 (4.3)	19 (27.1)
	Tibia	249	10 (4.0)	10 (4.0)	71 (28.5)
	Indeterminate	83	1 (1.2)		36 (43.4)
	Lower total	300	14 (4.7)	12 (4.0)	93 (31.0)
	Metacarpal	55	3 (5.5)	7 (12.7)	23 (41.8)
	Metatarsal	92	6 (6.5)	2 (2.8)	23 (25.0)
	Metapodial	153	5 (3.3)	3 (2.0)	47 (30.7)

1. Animal size classes are based on Brain's (1981) well-known system for antelopes. Parenthetical values in the fourth through sixth columns are percentages of the total number of identified specimens (NISP) for any row. Indeterminately identified pieces are those specimens that could be identified to a limb segment, as an upper (humerus or femur) or intermediate (radioulna or tibia) specimen but no further.

2. Percussion marks = pits and striae, in some cases associated with impact notches. Five additional specimens preserve notches only and a separate total of 53 impact flake specimens have been recovered from Swartkrans Member 3.

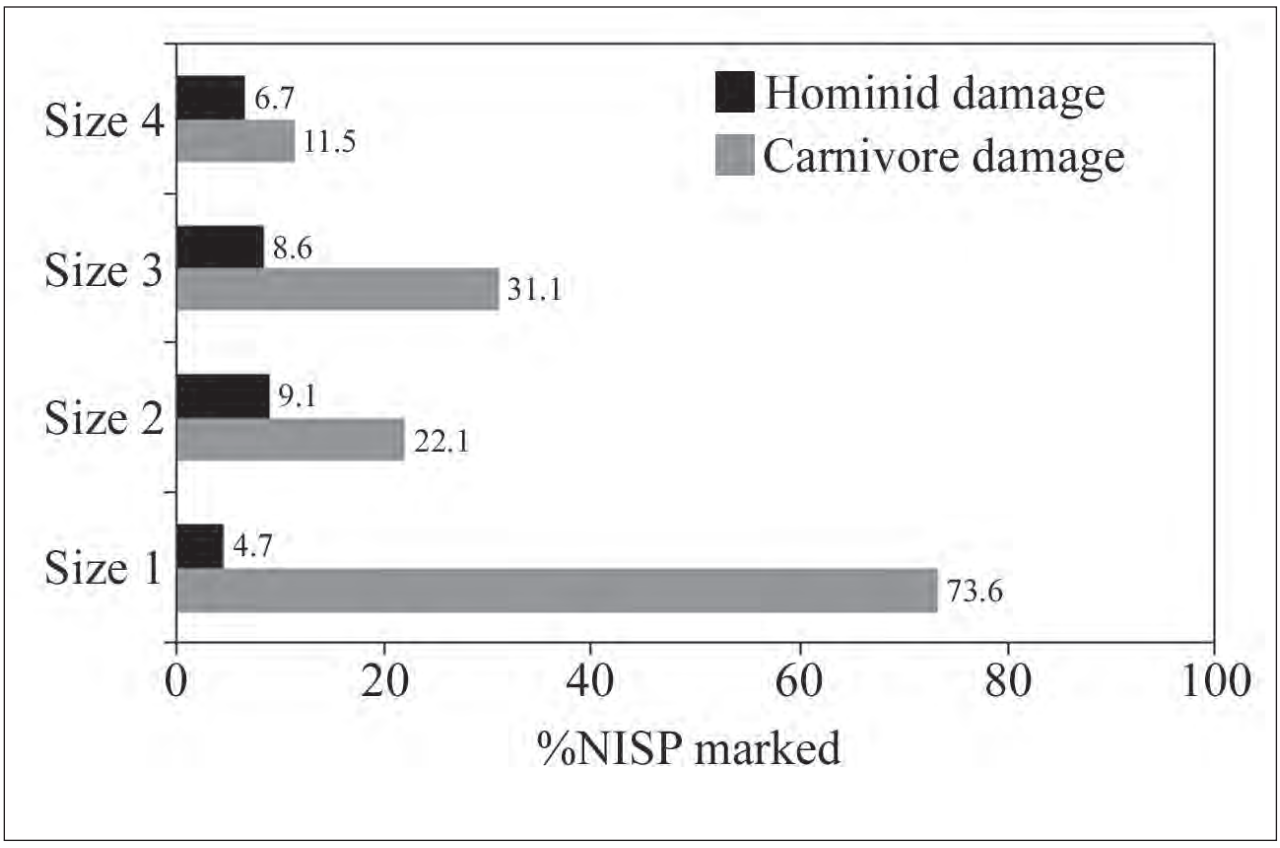

Figure 2. Frequencies of modified limb bone shaft specimens summarized by animal size class (see Brain, 1974, 1981 for animal body size classes). Hominid damage = cutmarked plus percussed specimens; Carnivore damage = tooth marked specimens; %NISP marked = percentage of total number of identified specimens modified. Note that except for the high percentage of tooth marked Size Class 1 specimens, there is a relatively low proportion of both types of damage preserved across animal body sizes.

Table 5. Summary of prehistoric bone surface modifications in Analytical Set II (the adjusted Swartkrans Member 3 limb bone shaft sample)[1]

	Cutmarks	Percussion marks[2]	Percussion flakes	Total hominid modified	Total carnivore modified
N	19	28	50	97	135
% of total adjusted NISP	0.6	0.9	1.6	1.5	4.3

1. Data adjusted to make the sample comparable to modern actualistic samples; adjustments modified the total number of identified specimens (NISP) in the Swartkrans assemblage to 3,151.

2. Percussion marks = pits and striae, in some cases associated with impact notches.

Assessing the carcass acquisition and exploitation abilities of hominids

Data on the anatomical locations of stone tool cutmarks, on both the intra-skeletal and intra-bone levels, are the most convincing and direct indications of the timing of hominid access to large animal carcasses (e.g., Bunn, 1982, Bunn and Kroll, 1986; Domínguez-Rodrigo, 1997, 1999a, 2002; Domínguez-Rodrigo and Pickering, 2003; Pickering and Domínguez-Rodrigo, in press) (Figure 3). Obviously, the Member 3 sample discussed here is biased because limb bone shafts are the only type of specimen that we examined. However, we did study *all* shaft fragments, regardless of element, and also stratified the sample by animal body size. Thus, the restricted analysis is more informative than might be supposed initially.

Considering the remains of all size classes from Member 3 combined, 8.0 % of all upper limb bone specimens are cutmarked, while 4.0 % of intermediate specimens are cutmarked and 4.7 % of lower specimens are cutmarked (Figure 4; Table 4). These differences in cutmarked percentages approach more closely statistical significance between upper and intermediate specimens (X^2 = 4.95, 1 d.f., p<0.05) and between upper and lower specimens (X^2 = 2.57, 1 d.f., p<0.2), than between intermediate and lower specimens (X^2 = 0.18, 1 d.f., p<0.5).

We believe, however, that a more elucidating comparison is that of cutmarked percentages for upper and intermediate specimens *combined* (n = 39, 5.6 % of the total upper plus intermediate NISP) with that of lower specimens. With regard to the distribution of overlying meat, the distinction between these two limb segment groups is profound: midshaft portions of ungulate upper and intermediate limb bones are heavily muscled, while no appreciable meat covers these portions on metapodials. Thus, the differential distribution of cutmarks on the midshafts of upper and intermediate limb segments compared to metapodials is informative behaviorally. Interestingly, in the total Member 3 sample, there is no statistically significant difference in cutmark percentages between these grouped limb segments (i.e., upper plus intermediate versus lower: X^2 = 0.41, 1 d.f., p<0.5), indicating that hominids were removing overlying soft tissues from *all* classes of limb bones at nearly equivalent frequencies. This suggests that hominids may have, at least occasionally, gained access to fleshed whole limb units of various sized ungulates that they then processed completely for overlying soft tissues, from humerus-to-metacarpal and femur-to-metatarsal. Statistically non-significant differences in cutmark percentages between each limb segment (upper, intermediate, lower) supports this contention for ungulate remains of every size: small (X^2 = 0.72, 2 d.f., p<0.5); medium (X^2 = 5.26, 2 d.f., p<0.1); large (X^2 = 0.37, 2 d.f., p<0.5) (Figure 5).

Cutmarks on metapodial midshafts indicate the removal of skin and/or tendons. In addition to the anatomical fact that a paucity of meat is available on these bones, numerous ethnoarchaeological and experimental observations (e.g., Bartram, 1993; Binford, 1978, 1981; Binford and Bertram, 1977; Bunn, 2001; Domínguez-Rodrigo, 1997, 1999a; Nilssen, 2000) also corroborate this inference. Whether skin and/or tendons were the *actual object* of hominid butchery directed at the Swartkrans metapodials is difficult to infer. In ethnoarchaeological and experimental contexts, metapodial skinning is an important initial step in at least two fundamental butchery scenarios, which are usually not mutually exclusive. The first is to simply remove skin from the whole limb unit (or, in most cases, whole carcass) for eventual defleshing. Second, metapodials are often skinned to prepare bones (i.e., expose cortical surfaces) for subsequent marrow extraction by hammerstone percussion.

Very few specimens in the Member 3 sample preserve the co-occurrence of cutmarks and hammerstone percussion marks (n = 4; only one of which is a metapodial specimen). Such a co-occurrence might be predicted on metapodial specimens had cutmarking activities been conducted to simply prepare bones for hammerstone percussion. However, we note that no refitting of specimens was attempted. Thus, whole limb bones may have been processed for overlying tissues and then broken open, resulting in currently disassociated fragments from the same original element, some of which preserve cutmarks and others that preserve percussion marks. Within the pooled sub-sample of hominid-modified specimens, percussion mark frequencies by individual element and

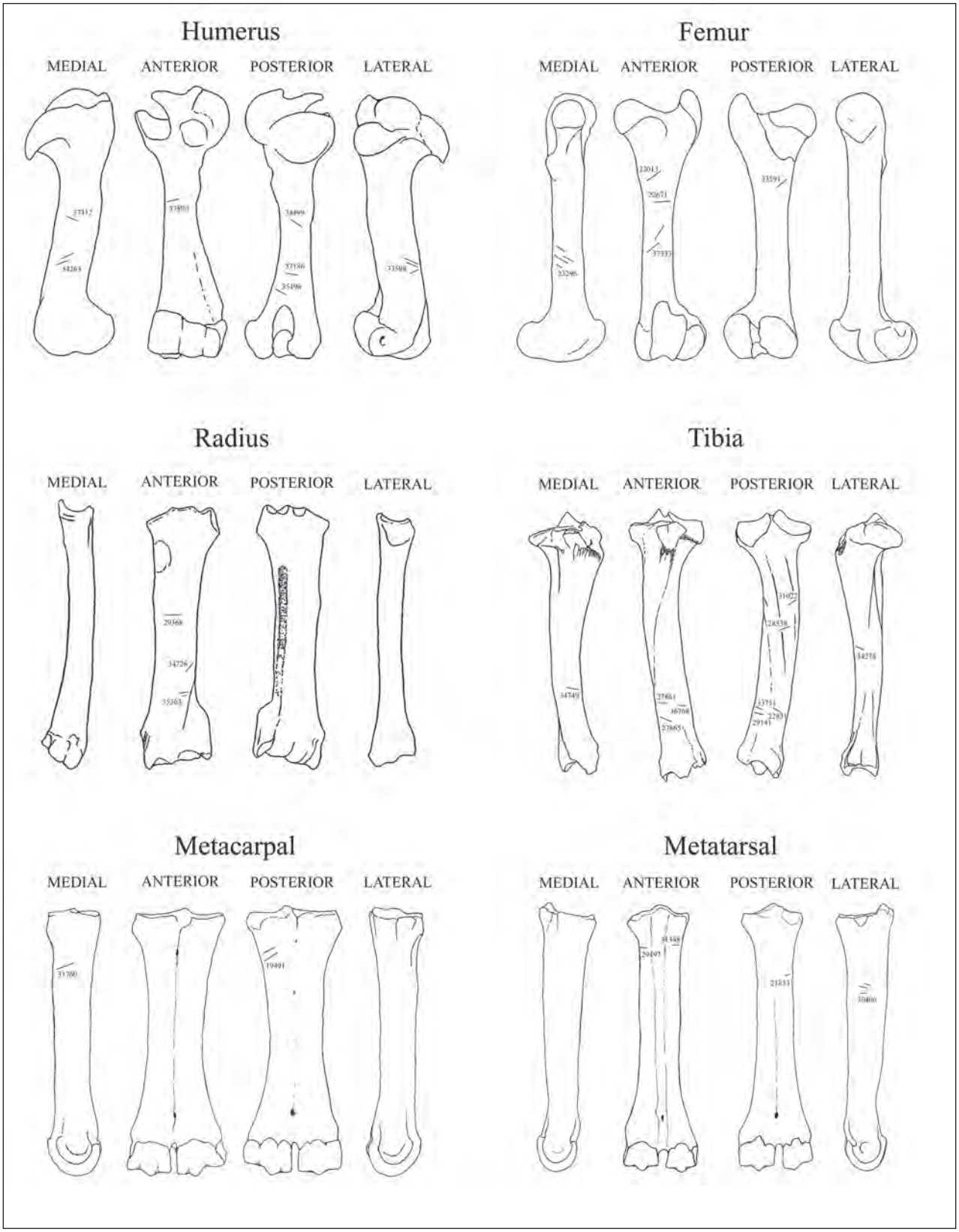

Figure 3. Lines on limb bone templates showing the distribution of cutmarks in the sub-sample from Member 3 that was identified to skeletal element. Cutmarks occur on elements from both sides of the body, but left limb bones are used as the standard templates in this figure. Specimen catalog numbers are indicated next to the corresponding cutmarks; all catalog numbers are preceded by SKX prefixes, which are dropped in this figure. Several specimens with cutmarks were identifiable to element, but they could not be placed exactly in position on the element templates, so those cutmarks are not illustrated in this figure. Those unrepresented specimens are: SKX 24494 (radioulna); 25304 (metacarpal); 28786 (femur); 30429 (femur); 31396 (femur); 37424 (metatarsal); 37540 (radioulna); 45748 (metatarsal).

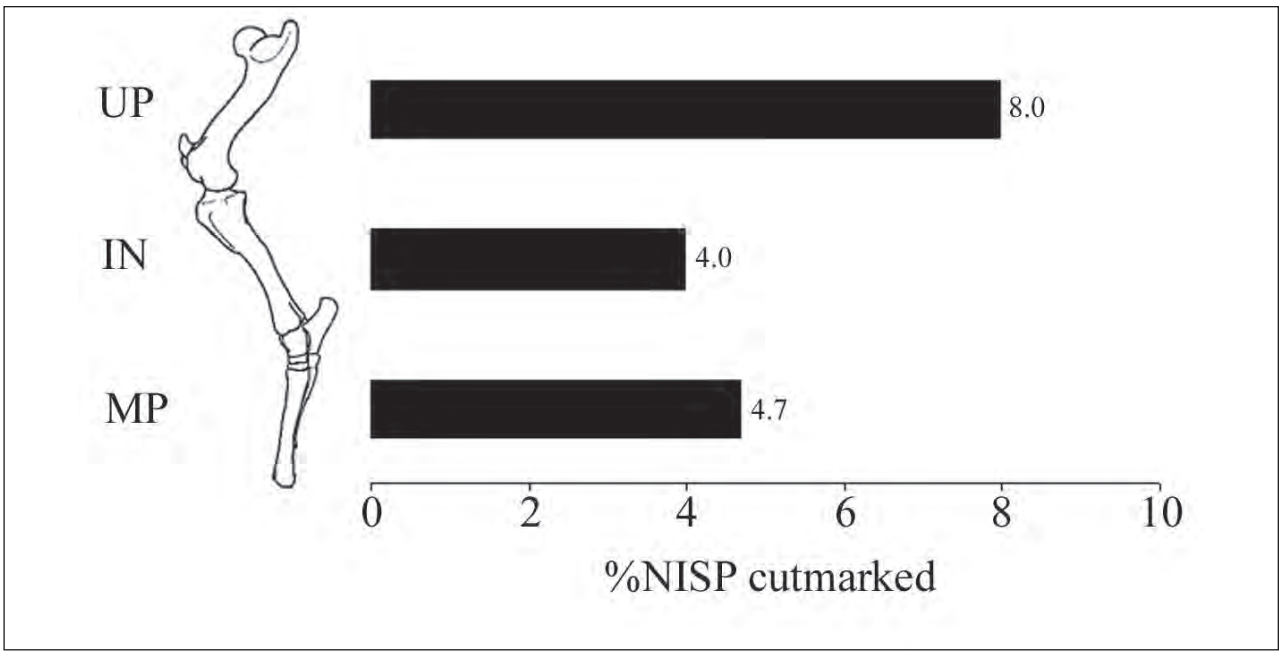

Figure 4. Cutmark percentages in the Member 3 limb bone shaft assemblage for all animal body size classes combined (see Brain, 1974, 1981 for animal body size classes). Abbreviations: UP = upper limb bones (humerus plus femur); IN = intermediate limb bones (radioulna plus tibia); MP = metapodials; %NISP = percentage number of identified specimens.

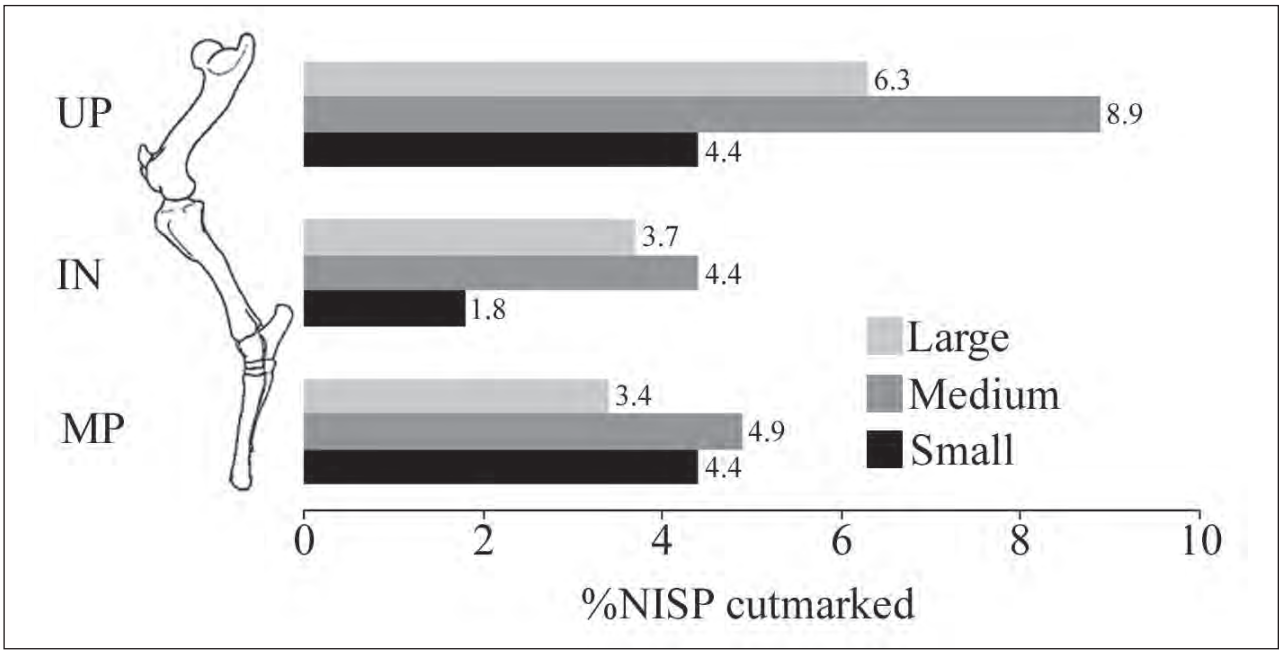

Figure 5. Cutmark percentages in the Member 3 limb bone shaft assemblage broken down by animal body size: small = Size Class 1; medium = Size Classes 2 and 3; Large = Size Class 4 and above (see text for explanation and Brain, 1974, 1981 for animal body size classes). Abbreviations: UP = upper limb bones (humerus plus femur); IN = intermediate limb bones (radioulna plus tibia); MP = metapodials; %NISP = percentage number of identified specimens.

limb segment are not significantly different from cutmark frequencies (e.g., for limb segment: X^2 = 1.45, 2 d.f., p<0.5). This seems to suggest fairly complete processing (i.e., both soft tissue removal and marrow extraction) of those limb bones that hominids acquired.

Less ambiguous for inferences of the carcass acquisition and utilization capabilities of Swartkrans hominids is the presence of cutmarked upper and intermediate midshaft limb bone specimens in the Member 3 sample. Even if the hypothesis of whole limb unit acquisition and deposition by hominids is false for Swartkrans Member 3, the fact that cutmarked upper and intermediate limb

bone midshaft specimens have been identified still indicates early access by hominids to animal carcasses. The midshaft portion of upper and intermediate limb bones is a region defleshed early in the feeding sequence of a carnivore that has primary access to a carcass. For example, Domínguez-Rodrigo (1999b) observed that upper and intermediate limb bones from 28 ungulate carcasses displayed a paucity of adhering flesh after ravaging by lions; midshaft sections on upper limbs in this dataset displayed a *complete* lack of flesh scraps, while flesh scraps on the midshaft portions of intermediate limb bones were poorly represented after lion ravaging. Assuming that the prehistoric carnivores of the Sterkfontein Valley operated similarly, there would be no reason for hominids to have imparted cutmarks on upper and intermediate limb bone midshafts had they been relegated to scavenging passively (i.e., late access to carcasses) from the remains of picked-over carnivore kills (see, Bunn, 2001; Domínguez-Rodrigo, 2002; Domínguez-Rodrigo and Pickering, in press; Pickering and Domínguez-Rodrigo, 2004). No flesh would have been present on those bone portions in that scenario and thus there would be no reason for hominids to put a stone tool edge to upper and intermediate bone midshafts; in fact, there would be good reason *not* to do this because slicing into bone simply dulls the cutting edge of a tool (e.g., Bunn, 2001). Experimental butchery data corroborate the eloquent argument based on logic that cutmarks are unexpected on previously defleshed limb bone midshafts. For example, Domínguez-Rodrigo's (1997, 1999a) and Nilssen's (2000) large, modern datasets demonstrate convincingly that cutmarks from activities *other than defleshing* (i.e., skinning, disarticulation) *almost never* occur on upper and intermediate limb bone midshafts.

Summary and conclusions

At face value, the Swartkrans Member 3 fauna would appear to be of fairly low integrity, and thus its potential for reconstructing early hominid carcass foraging minimal. However, the Member 3 assemblage preserves a much lower proportion of single bone specimens that have co-occuring hominid- and carnivore-derived surface modifications than do modern actualistic assemblages derived by the interdependent actions of both agents. This suggests instead that the fossil assemblage can actually be divided into two fairly independently formed and high integrity sub-assemblages—one created largely by the actions of hominids and the other created largely by the actions of carnivores (see also, Egeland et al., 2004; Pickering et al., 2004a, 2005). Overall, tooth-marked specimens are approximately three and a half times as common as hominid-modified specimens in the limb bone shaft subassemblage as a whole. However, when taking into account diagenetic breakage, cortical surface preservation and differential fragmentation, hominids and carnivores appear to have contributed similarly to the formation of the Member 3 limb bone shaft subassemblage.

Additionally important is the finding that evidence of hominid activity that *is* preserved is informative behaviorally. Cutmarks and percussion marks are distributed fairly evenly across all limb elements, suggesting fairly complete processing of whole limb units by hominids. By extrapolation, this might mean that hominids were acquiring whole carcasses for processing. Based on actualistic observations, cutmarks on intermediate and especially upper limb bone midshaft specimens indicate, at the very least, early access to carcass parts typically defleshed completely by primary carnivores early in their feeding sequences.

With addition of this new cutmark data from Swartkrans Member 3, the southern-most continental datum so far known, a pattern in the zooarchaeology of Early Stone Age Africa is confirmed. As with the Member 3 archaeofauna, cutmarks occur on upper and intermediate limb bone midshafts in the important assemblages from FLK *Zinj*, BK, FxJj 50 and the ST site complex (e.g., Bunn, 1982; Bunn and Kroll, 1986; Domínguez-Rodrigo, 2002; Domínguez-Rodrigo et al., 2002; Oliver, 1994; Monahan, 1996; see also Domínguez-Rodrigo et al., 2005)—suggesting hominid access at all sites to the largely fleshed carcasses of ungulates and contradicting predictions of passive scavenging models.

Given the extreme polarization of research groups working on the issue of early hominid access to large animal carcasses, it seems unlikely that our conclusions will be embraced by all. However, we will still be very gratified if this study accomplishes another broader goal of bringing important South African zooarchaeological data into the ongoing consideration by paleoanthropologists of this important topic.

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Appendix

Butchered fossils identified in the Swartkrans Member 3 limb bone shaft archaeofauna. Animal size classes are based on Brain's (1981) well-known system for antelope. The catalog number of each specimen is preceded by a SKX prefix, which is dropped in the following Tables 1–3; specimens are listed here in numerical order by catalog number. Some listed specimens were recovered from screen bags, in which multiple specimens were originally assigned the same catalog number; in those cases we distinguished each modified specimen with a unique suffixed number after an added decimal point.

Following the tables, the hominid butchered bones from Swartkrans Member 3 are illustrated in two figures.

Table 1. Cutmarked specimens (PM = percussion marks; TM = tooth marks)

Size Class	Specimen number	Element	Other damage
1	29674.2	Metapodial	
	33575	Upper	TM
	33598	Humerus	TM
	33751	Tibia	
	37424	Metatarsal	
2	21853	Metatarsal	
	22068	Limb bone	
	22425	Intermediate	
	22671	Femur	
	24494	Radius	
	25304	Metacarpal	TM
	27861	Tibia	
	28538	Tibia	PM
	28786	Femur	TM
	29055	Limb bone	
	29141	Tibia	
	29156	Upper	TM
	29273	Limb bone	
	29674.3	Limb bone	PM
	30617.1	Upper	TM
	31022	Tibia	
	31348	Metatarsal	
	31396	Femur	TM
	31474	Upper	
	31760	Metacarpal	
	31765	Upper	
	32013	Femur	TM
	32905	Metapodial	
	33591	Femur	
	34278	Tibia	
	34315	Limb bone	
	34564	Metapodial	
	34749	Tibia	TM
	35363	Radius	
	36741	Limb bone	
	37186	Humerus	
	37890	Humerus	
3	19491	Metacarpal	TM
	22831	Tibia	TM
	23296	Femur	PM, TM
	27865	Tibia	
	28225	Upper	
	29368	Radius	TM
	29497	Metatarsal	
	30406	Metatarsal	
	30429	Femur	TM
	30631	Upper	TM
	34499	Humerus	
	34636	Upper	
	34726	Radius	
	36690	Metapodial	
	36768	Tibia	
	36805	Limb bone	
	37333	Femur	
	37412	Humerus	
	45758	Metatarsal	
4	34263	Humerus	
	35498	Humerus	
	36231	Metapodial	TM
	37540	Radioulna	

Table 2. Percussion marked specimens (CM = cutmarks; TM = tooth marks)

Size Class	Specimen number	Element	Other damage
1	94	Femur	
	24896	Metacarpal	
	29993.1	Tibia	
	31091	Limb bone	
	32182	Metacarpal	
	33540	Limb bone	
	36044	Femur	
	37013	Metacarpal	
	37409	Tibia	
	37863.1	Femur	
2	20057	Metacarpal	
	22658	Limb bone	
	26114	Limb bone	
	28095	Radius	
	28538	Tibia	CM
	28603	Metatarsal	
	28641	Radius	
	29674.3	Limb bone	CM
	29813	Femur	
	30081	Tibia	
	30917.1	Tibia	
	31040	Radius	
	33441	Femur	
	34844	Femur	
	35125	Tibia	
	35727	Humerus	
	36692	Humerus	
	37218	Metacarpal	
	37291	Humerus	
	37947	Limb bone	
3	19526	Limb bone	
	21563	Metacarpal	
	21858	Tibia	
	23296	Femur	CM, TM
	26726	Tibia	
	27348	Humerus	
	30638	Metapodial	
	32476	Humerus	
	33269	Tibia	
	33497	Femur	TM
	34639	Tibia	
	36776	Metatarsal	TM
	36806	Humerus	TM
4	19514	Metapodial	
	32532	Metacarpal	
	36231	Metapodial	CM

Table 3. Impact flakes

Size Class	Specimen number	Element
2	30035	Humerus
?	22320	Limb bone
	22320.1	Limb bone
	22320.2	Limb bone
	22948	Limb bone
	23320	Limb bone
	24675.2	Limb bone
	24675.3	Limb bone
	29011.1	Limb bone
	29011.2	Limb bone
	29090	Limb bone
	29321.1	Limb bone
	29321.2	Limb bone
	29361	Limb bone
	29391	Limb bone
	29452.1	Limb bone
	29452.2	Limb bone
	29485	Limb bone
	29610	Limb bone
	29753	Limb bone
	29962	Limb bone
	30022	Limb bone
?	30090	Limb bone
	30188	Limb bone
	30416	Limb bone
	30581	Limb bone
	30598	Limb bone
	30670	Limb bone
	30767	Limb bone
	30835	Limb bone
	30860.1	Limb bone
	30860.2	Limb bone
	31571	Limb bone
	32455	Limb bone
	32884	Limb bone
	33230	Limb bone
	33416	Limb bone
	33625	Limb bone
	33637	Limb bone
	33652	Limb bone
	34480	Limb bone
	34506	Limb bone
	34564	Limb bone
	34611	Limb bone
	34675	Limb bone
	34675.1	Limb bone
	34675.2	Limb bone
	34700	Limb bone
	35057	Limb bone
	35810	Limb bone
	36967	Limb bone
	37619	Limb bone
	37929.1	Limb bone

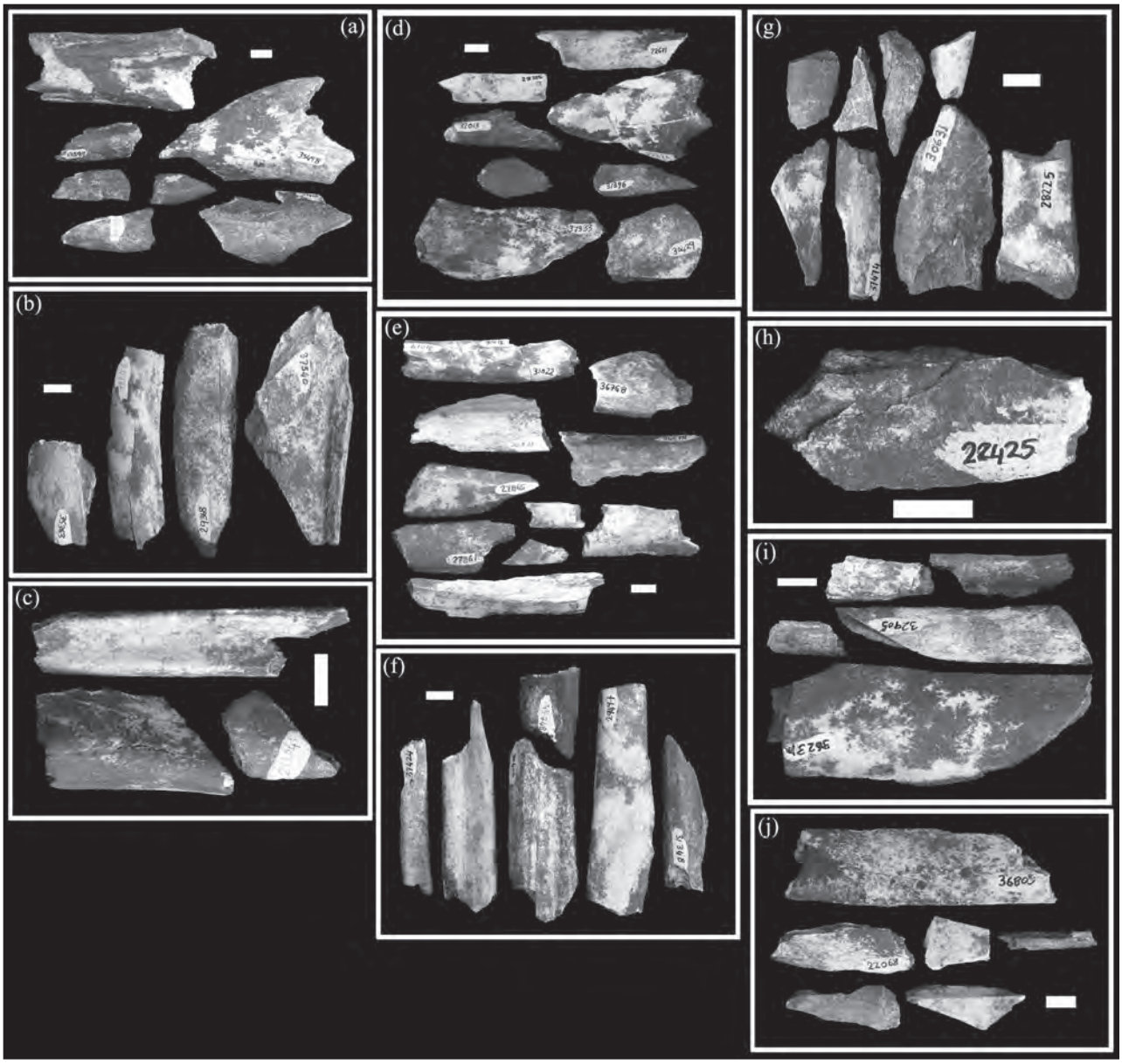

Figure 1. The sample of cutmarked fossils from Swartkrans Member 3. Note that two cutmarked specimens, SKX 24494 (radius) and 34315 (limb bone shaft fragment), identified in an earlier study (Brain, 1993) are not figured here.

Box (a), humerus specimens: top row = SKX 34263; second row (left to right) = SKX 33598, 35498; third row (left to right) = SKX 37890, 37186; fourth row (left to right) = SKX 34499, 37412.
Box (b), radioulna specimens (left to right) = SKX 35363, 34726, 29368, 37540.
Box (c), metacarpal specimens: top row = SKX 31760; second row (left to right) = SKX 19491, 25304.
Box (d), femur specimens: top row = SKX 22671; second row = SKX 28786; third row (left to right) = 32013, 23296; fourth row (left to right) = SKX 33591, 31396; fifth row (left to right) = SKX 37333, 30429.
Box (e), tibia specimens: top row (left to right) = SKX 31022, 36768; second row (left to right) = SKX 22831, 34278; third row (left to right) = SKX 27865, 33751, 34749; fourth row (left to right) = SKX 27861, 29141; fifth row = SKX 28538.
Box (f), metatarsal specimens (left to right) = SKX 37424, 21853, 45758 (top), 30406 (bottom), 29497, 31348.
Box (g), upper (humerus or femur) specimens: top row (left to right) = SKX 34636, 31765, 30617.1, 33575; second row (left to right) = SKX 29156, 31474, 30631, 28225.
Box (h), intermediate (radioulna or tibia) specimen = SKX 22425.
Box (i), metapodial specimens: top row (left to right) = SKX 36690, 34564; second row (left to right) = SKX 29674.2, 32905; third row = SKX 36231.
Box (j), limb bone shaft specimens: top row = SKX 36805; second row (left to right) = SKX 22068, 36741, 29055; third row (left to right) = SKX 29674.3, 29273.

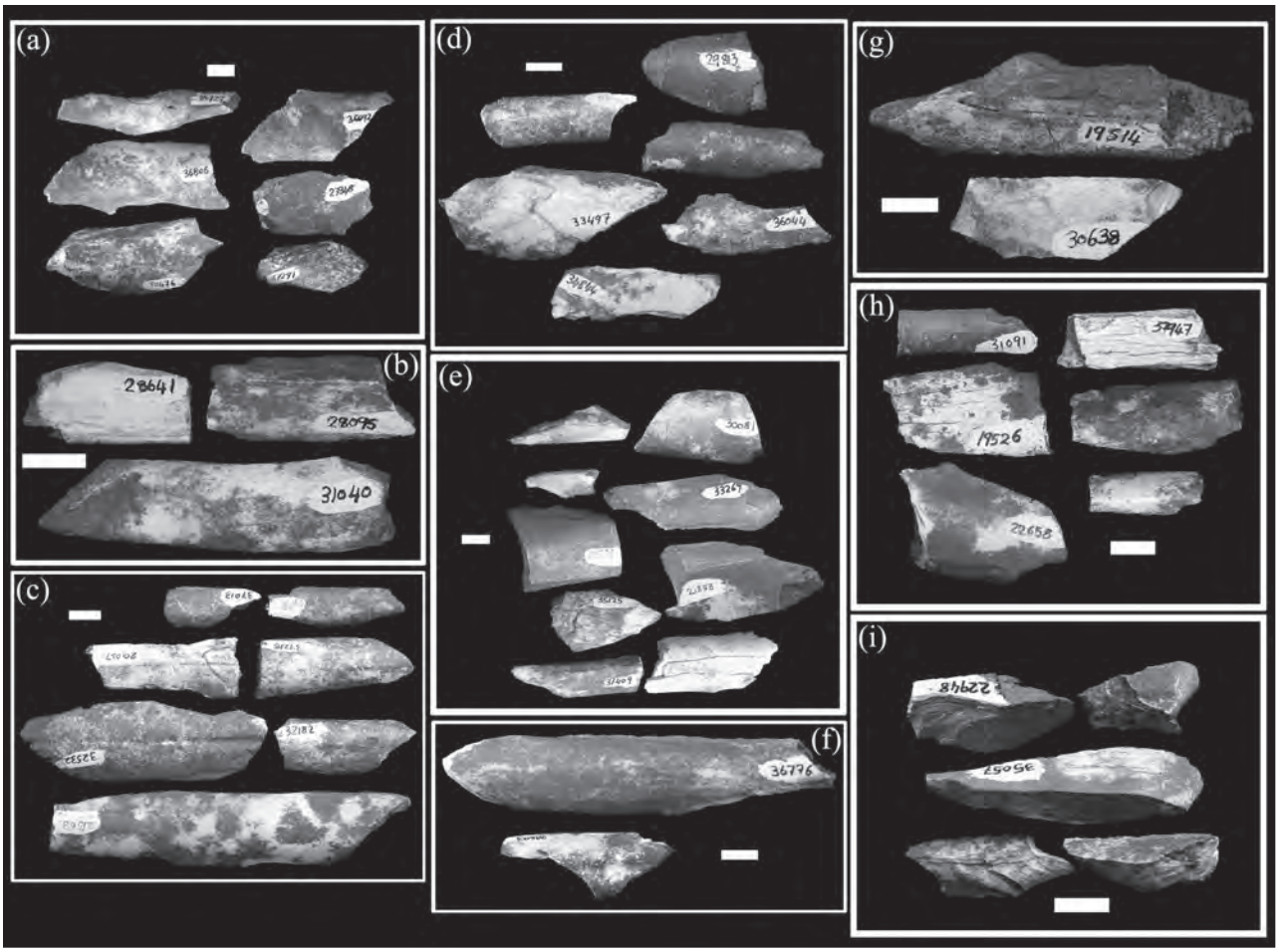

Figure 2. The sample of percussion marked fossils from Swartkrans Member 3. Note that several percussion marked specimens are not figured below because they are pieces that also preserve cutmarks and are thus illustrated in the Figure 1 composites above. These specimens include: SKX 23296 (femur), 28538 (tibia), 29674.3 (limb bone shaft) and 36231 (metapodial). One additional percussed specimen, SKX 33441 (femur) is also absent in the figure above.

Box (a), humerus specimens: top row (left to right) =SKX 35727, 36692; second row (left to right) = SKX 36806, 27348; third row (left to right) = SKX 32476, 37291.

Box (b), radioulna specimens: top row (left to right) = SKX 28641, 28095; second row = SKX 31040.

Box (c), metacarpal specimens: top row (left to right) = SKX 37013, 24896; second row (left to right) = SKX 20057, 37218; third row (left to right) = SKX 32532, 32182; fourth row = SKX 21563.

Box (d), femur specimens: top row = SKX 29813; second row (left to right) = SKX 94, 37863.1; third row (left to right) = SKX 28359, 36044; fourth row = SKX 34844.

Box (e), tibia specimens: top row (left to right) = SKX 30917.1, 30081; second row (left to right) = SKX 29993.1, 33269; third row (left to right) SKX 26726, 21858; fourth row = SKX 35125; fifth row (left to right) = SKX 37409, 34639.

Box (f), metatarsal specimens: top row = SKX 36776; second row = SKX 28603.

Box (g), metapodial specimens: top row = SKX 19514; second row = SKX 30638.

Box (h), limb bone shaft specimens: top row (left to right) = SKX 31091, 37947; second row (left to right) = SKX 19526, 26114; third row (left to right) = SKX 22658, 33540.

Box (i), representative examples of impact flakes: top row (left to right) = SKX 22948, 30670; second row = SKX 35057; third row (left to right) = SKX 34506, 29485.