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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 4

HOMINIDS AND CARNIVORES AT KROMDRAAI AND OTHER QUATERNARY SITES IN SOUTHERN AFRICA

J. FRANCIS THACKERAY

ABSTRACT

This study serves to examine carnivore:ungulate ratios and mean bone flake lengths of fauna from South African Plio-Pleistocene assemblages from Kromdraai A and B, compared to other assemblages from sites in the Sterkfontein Valley, including Swartkrans (Members 1, 2 and 3) and Sterkfontein (Members 2 and 5). Comparisons are made with Middle and Later Stone Age assemblages from southern Africa, and faunal assemblages accumulated by carnivores (brown hyena, spotted hyena and leopard). Use is made of carnivore: ungulate ratios as well as mean flake lengths of ungulate bones to facilitate the identification of agents of accumulation, and to assess the extent to which one or other agent was responsible for accumulating any given assemblage. The data are used together to establish a general model whereby scavenging activities by hominids may be distinguished from activities associated with longer-term occupation. Although Kromdraai A has previously been referred to as a “non-hominid site,” the discovery of stone artefacts indicates a hominid presence, although no hominid fossils have as yet been found at this site, contrasting with Kromdraai B where stone artefacts and hominids (both *Paranthropus* and early *Homo*) have been found. It is suggested that polyhedral core tools (choppers) associated with Early Acheulian/Developed Oldowan assemblages at Kromdraai A may have been used opportunistically to obtain bone marrow from sites which were also used at least temporarily by large carnivores such as sabre-tooth cats, which preyed primarily on juvenile alcelaphines.

INTRODUCTION

Kromdraai is situated within 2 kilometres east of Sterkfontein, and consists of two localities in close proximity to each other, Kromdraai A (KA) and Kromdraai B (KB). The latter yielded the type specimen of *Paranthropus (Australopithecus) robustus* (TM 1517), described by Robert Broom (1938). The Olduvai Event is represented in the KB deposits (Thackeray et al., 2002), and a minimum date of 1.95 million years ago (Mya) has been indicated for the type specimen of *P. robustus* from Kromdraai B. This is similar in age to the type specimens of *P. boisei* (OH 5) and early *Homo* (OH 7) at Olduvai Bed I, dated circa 1.8 Mya.

Until recently it was thought that all of the hominids at KB represented robust australopithecines (Thackeray et al., 2001), and it appeared anomalous that stone tools from Kromdraai B were present in the apparent absence of early *Homo* at this locality. However, at least one specimen (KB 5223) has been identified as early *Homo* (Braga and Thackeray, 2003). It is thus evident that stone tools, including polyhedral cores, were used at KB where both early *Homo* and *P. robustus* were present, as at Swartkrans (Members 1 and 2), Sterkfontein (Member 5), Olduvai (Bed I) and various other early Pleistocene sites in Africa.

No hominid fossils have as yet been discovered at KA, but stone tools associated with Developed Oldowan/Early Acheulian technology indicate a hominid presence (Kuman et al., 1997; Thackeray, 1998). The stone tool assemblages at KA include polyhedral cores of the kind which have been found at KB and at Olduvai Bed I.

KB has been considered to have been a potential death trap, but carnivores may have played a role as accumulators of faunal assemblages at both KA and KB (Brain, 1981; Thackeray, 1999; Vrba, 1976).

Although no hominid fossils have as yet been discovered at KA, several questions require attention, regarding agents of accumulation:

1. To what extent, if at all, were hominids responsible for the accumulation of faunal assemblages at Kromdraai A and B?
2. To what extent were carnivores responsible for the accumulation of KA and KB faunal assemblages?
3. In what ways, if at all, do faunal assemblages from KA and KB differ from each other?
4. In what manner do the KA and KB assemblages resemble faunal assemblages from Swartkrans (Members 1,2 and 3) and Sterkfontein (Member 5)?
5. In what manner do early Pleistocene assemblages from Sterkfontein, Swartkrans and Kromdraai assemblages differ from late Quaternary assemblages associated with Middle Stone Age (MSA) and Later Stone Age (LSA) hominids, representing *H. sapiens*?

METHOD

In this study I use two indices to facilitate the identification of agents of faunal accumulation. Firstly, carnivore:ungulate ratios can be cautiously used to infer the degree to which carnivores might have contributed to faunal accumulations (Klein, 1975), under the assumption that carnivores tend to consume ungulates as well as other carnivores. Secondly, mean flake lengths (MFL) of long bones (primarily those of ungulates) can reflect hominid activity under the assumption that a high degree of fragmentation is associated with the breakage of bone shafts for the extraction of marrow (Brain, 1981).

The term “bone flake” as used here has been defined by Brain (1974), referring to shaft fragments of ungulate long bones which have been broken through the shaft such that less than half the circumference of the shaft section is intact. Variability in the degree of fragmentation can be assessed not only in terms of patterns in the size distribution of bone flakes, using histograms to illustrate frequencies of bone flakes measured in size classes (Brain, 1981), but also in terms of mean flake length and associated standard deviations.

For purposes of this study, carnivore ungulate ratios (CUR) are calculated by means of the following formula:

$$\text{CUR} = \frac{\text{MNI carnivores}}{\text{MNI ungulates}} \times 100$$

Log-transformed CUR and MFL values have been used to facilitate comparison of these indices, within and between sites. Further, attempts have been made to assess activities of one or more agents of accumulation,

by comparing CUR and MFL values against each other, similar to the approach adopted by Isaac (1976) when comparing the relative frequencies of bone and stone artefacts associated with a range of hominid activities. In this case, reference is made not only to hominids but also to carnivores as potential agents of accumulation. The expectation is that high carnivore ungulate ratios (CUR), and a low degree of bone fragmentation (associated with high MFL values) would generally reflect a high degree of carnivore activity at a site. Conversely, low CUR and low MFL values would be expected to be associated with a high probability of having been associated with hominid activity, assuming that hominids generally do not consume carnivores, and assuming that a high degree of fragmentation of ungulate long bones is associated with the tendency to break bones for marrow extraction.

The approach adopted here is an example of how CUR and MFL indices may be used together to explore patterning in their relationship, in an attempt to identify agents of accumulation. However, it is recognized that additional taphonomic approaches, including the analysis of tooth-marking and percussion damage, need to be adopted, and potential post-depositional factors should also be considered. The primary objective in this study is to examine CUR and MFL indices in order to generate hypotheses which may be tested on the basis of other taphonomic studies.

MATERIALS

The materials used in this study are based on published and unpublished studies of faunal assemblages from the following South African sites: Bushman Rock Shelter in the Mpumalanga Province and Wilton Rock Shelter and in the Eastern Cape Province (Brain, 1981); Nelson Bay Cave, Klasies River Mouth and Swartklip situated in the Western Cape Province (Klein, 1972, 1975, 1976). Also included are faunal assemblages from Fackeltrager (Brain, 1981) and Apollo 11 (Thackeray, 1979) in Namibia, and Pomongwe, a site in Zimbabwe (Brain, 1981). All of these samples date to the Late Quaternary. Plio-Pleistocene assemblages from the Gauteng Province include samples from Sterkfontein (Brain, 1981, Pickering et al., 2004), Swartkrans (Brain, 1981; Watson, 1991) and Kromdraai (Brain, 1981; Vrba, 1976; Thackeray, 1999).

In most cases, both MFL and CUR values could be calculated for assemblages from these sites. In other instances, only one or other index could be determined from available data.

RESULTS

The results of this study are presented in Table 1, listing carnivore:ungulate ratios and mean flake lengths with associated standard deviations and sample sizes. The distributions of CUR and MFL are presented graphically in Figure 1.

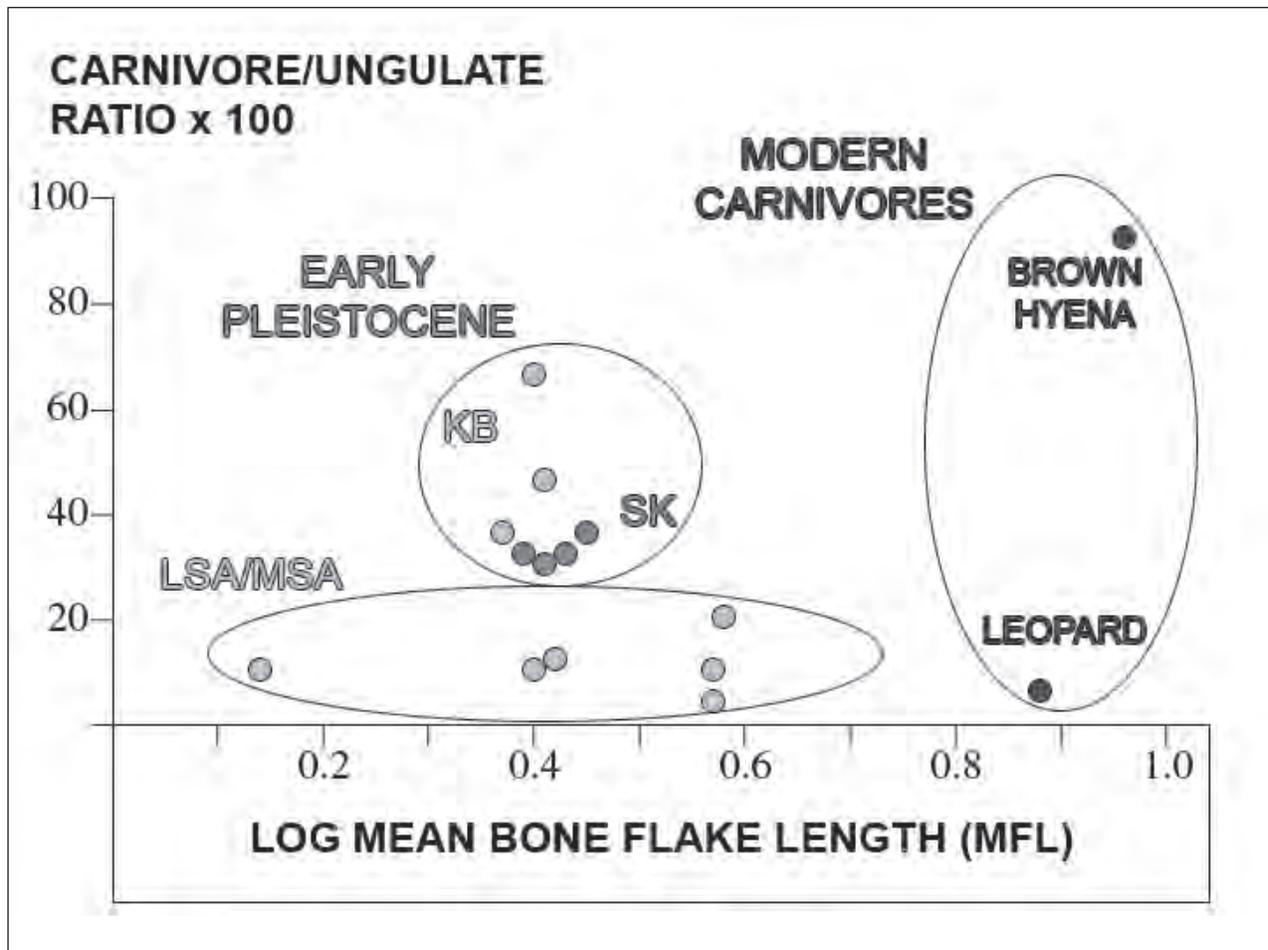


Figure 1. Distribution of MFL (mean flake length) and CUR values (carnivore:ungulate ratios) for various faunal assemblages from southern Africa. The Later Stone Age (LSA) and Middle Stone Age (MSA) assemblages date to the Late Quaternary.

DISCUSSION

Mean flake lengths (MFL) for Late Quaternary assemblages are consistently low, ranging between 1.39 \pm 0.14 cm ($n=33,891$) at Wilton Rock Shelter, to 3.75 \pm 0.57 cm ($n=2723$) at Bushman Rock Shelter. Intermediate MFL values have been obtained for the Apollo 11 assemblages (MFL = 2.40 \pm 0.38 cm, $n = 10,854$). As noted by Brain (1981) and Thackeray (1979), the high degree of fragmentation can be associated with a high probability of hominid activity, related to the breakage of long bones for marrow.

By contrast, the mean bone flake length for assemblages accumulated by brown hyenas (MFL = 11.05 \pm 1.04 cm, $n=2887$) is significantly higher ($p=0.05$; Students t -tests) than MFL values calculated for Late Quaternary faunal assemblages associated with human activity, notably those from Wilton Rock Shelter, Bushman Rock Shelter, Apollo 11, Fackeltrager and Pomongwe (Table 1). Similarly, the mean bone flake length measured from an assemblage accumulated by spotted hyenas (MFL = 7.20 \pm 0.86 cm, $n = 220$) is high, significantly higher than the mean MFL values obtained for Late Quaternary hominid sites ($p=0.05$; Students t -tests).

Surprisingly, the mean flake length of bone flakes from Kromdraai A is relatively low (MFL = 2.52 \pm 1.01 cm, $n=3016$), similar to mean values for Late Quaternary assemblages from sites such as Fackeltrager (MFL = 2.50 \pm 0.40 cm, $n=757$) and Apollo 11 (MFL = 2.40 \pm 0.38 cm, $n=10,854$). Noticeable differences are however recognisable in terms of the standard deviations associated with mean values of flake length. The low standard deviations associated with low MFL values of Late Quaternary assemblages reflect a consistently high degree of fragmentation, whereas the KA assemblage is associated with a higher degree of variability in bone flake length. The KA sample include relatively large flakes. The situation at Kromdraai is different in the sense that the assemblage may have included some degree of carnivore activity, although the average flake length is small, similar to that of some Late Quaternary assemblages.

The three assemblages from Kromdraai B show the same pattern displayed at Kromdraai A. The mean flake lengths range from 2.48 - 2.73 cm, and the associated standard deviation for one sample (KB 1) is relatively high, again suggesting some degree of carnivore activity. The standard deviations associated with

Table 1. Mean flake lengths (MFL) and carnivore: ungulate ratios (C/U x 100) for faunal assemblages from Kromdraai, Swartkrans, Sterkfontein and other hominid sites in southern Africa, and for assemblages accumulated by spotted hyena, brown hyena and leopards

	MFL	s.d.	n.	log MFL	C/Ux100	log (C/Ux100)
Kromdraai						
KA (D13)	2.52	1.01	3016	0.401	34.5	1.537
KB 1	2.48	1.16	1512	0.394	35.7	1.533
KB 2	2.73	0.44	627	0.436	66.7	1.824
KB 3	2.79	0.45	748	0.446	46.2	1.665
Swartkrans						
SK M1 (HR & LB)	2.87	0.46	6171	0.458	35.3	1.547
SK M2	2.74	0.44	6835	0.438	32.6	1.513
SK M3	3.00	0.48	8923	0.477	36.7	1.565
SK M5	3.90	0.59	757	0.591	18.5	1.267
Sterkfontein M5	5.47	3.12	89	0.738	16.6	1.220
Sterkfontein M2	-	-	-	-	250	2.39
Wilton	1.39	0.14	33891	0.143	11.1	1.045
Bushman Rock	3.75	0.57	2723	0.574	1.7	0.230
Apollo 11	2.40	0.38	10854	0.380	10.4	1.017
Fackeltrager	2.50	0.40	757	0.397	11.1	1.045
Pomongwe	3.73	0.57	9539	0.572	5.3	0.724
Carnivore-accumulated assemblages						
Spotted hyena	7.20	0.86	220	0.857	1.15	0.060
Brown hyena	11.05	1.04	2887	1.043	97.2	1.987
Swartklip					28.9	1.461
Leopards (Kafue)	-	-	-		3.6	0.556
Leopard (Serengeti)	-	-	-		5.1	0.707
Leopard (Serengeti)	-	-	-		3.9	0.591

MFL values of two other assemblages (KB2 and KB3) indicate a lower degree of variation in flake length, closer to that found in Late Quaternary hominid sites. The implication is that both carnivores and hominids are likely to have contributed to the accumulation of KB faunal assemblages.

MFL values for Swartkrans samples range between 2.87 and 3.00 cm, corresponding closely to values obtained for Kromdraai A and B assemblages. The degree of vari-

ation in flake length in the Swartkrans assemblages corresponds closely to values obtained for Kromdraai samples KB2 and KB 3, again reflecting similarities with Late Quaternary assemblages associated with some degree of hominid activity.

Flake length variability needs to be assessed in the context of carnivore:ungulate ratios which are presented in Table 1.

Remarkably, the distribution of MFL and CUR

values for Kromdraai A, Kromdraai B and Swartkrans Members 1, 2 and 3 are all tightly clustered together (Figure 1), and are separated from late Quaternary assemblages by virtue of having higher carnivore:ungulate ratios. Clearly the Swartkrans and Kromdraai assemblages are associated with some degree of carnivore activity. By comparison with CUR values of modern carnivores, it would seem that CUR values for KA and KB correspond most closely to those of assemblages accumulated by brown hyena, but other carnivores may certainly have been involved, including large carnivores such as *Dinofelis*, which have previously been identified as a potential agent of accumulation at KA (Brain, 1981; Vrba, 1976; Thackeray and von Leuvan-Smith, 2001). The degree of fragmentation of bone flakes at KA, KB and at Swartkrans (Members 1 2 and 3), combined with relatively high CUR values, suggest that while carnivores contributed to some extent to the accumulation of faunal remains, hominids may have contributed to the fragmentation of long bone shafts.

Polyhedral cores and chopper artefacts are present at KA, KB, and Members 1, 2, and 3 at Swartkrans. As a working hypothesis, one might suggest that these stone artefacts were used partly to break open long bones of animals that had been killed by carnivores. This hypothesis can be tested by chemical analysis of working edges of polyhedral cores. The intention of current and future research is to explore the working edges of such tools to determine whether or not bone apatite residues are present in the interstices of stone tools where apatite may have been deposited, if the tools had been used to break open long bones for marrow. Several stone artefacts from Kromdraai have been examined using X-ray diffraction at the NECSA facility in Pretoria. Preliminary results indicate the presence of apatite on the working edge of a polyhedral core from Kromdraai A (KA 2776), consistent with the possibility that such artifacts were used to break open bone shafts (Thackeray et al., 2005).

The assemblages from Sterkfontein considered in this study, namely those from Members 2 and 5, are associated with contrasting scenarios. In the case of Member 2, the carnivore:ungulate ratio based on data recently published by Pickering et al. (2004) is high (Table 1). The Silberberg Grotto is likely to have been a deathtrap into which "Little Foot" (a complete skeleton of *Australopithecus*) and other mammals fell (Clarke, 1998), including both carnivores as well as primates (Pickering et al., 2004). Carnivore:ungulate ratios may be high due to a bias towards carnivores, associated with an infrequency of ungulates falling into the death trap.

A small sample of ungulate long-bones from Sterkfontein Member 5 is available for analysis. The mean flake length is 5.47 +/- 3.12 cm (n=89), which is low in comparison with MFL values for carnivore-accumulated assemblages. In addition, Sterkfontein Member 5 is characterised by a relatively low carnivore-ungulate ratio, lower than those obtained from Kromdraai and Swartkrans, placing the values for Sterkfontein Member

5 closer to the distribution of MFL and CUR values of Late Quaternary sites, associated primarily with hominid activity. However, some degree of carnivore activity is likely to have been associated with the Sterkfontein Member 5 sample which has a CUR value that is slightly higher than those of Late Quaternary hominid-accumulated assemblages.

CONCLUSION

It is probable that faunal assemblages from Kromdraai A, Kromdraai B, and Swartkrans (Members 1, 2, and 3) were accumulated in part by carnivores, as has been previously suggested (Brain, 1981; Vrba, 1976; Thackeray, 1999; Thackeray and von Leuvan-Smith, 2001), but hominids could have played a significant role in contributing to the fragmentation of bone. At Kromdraai A, hominids may have been using the site opportunistically to access bone marrow, notably at times when the site was not occupied by carnivores. It would seem probable that KA was more frequently used as a lair by carnivores, and that hominids did not make regular use of the site as an occupation site. When they were present at the site, it would seem probable that they did so temporarily, and discarded artefacts at the site without necessarily manufacturing them there. Stone flake debitage is uncommon relative to core tools. In a study of KA stone tool assemblages, only 24 flakes were found compared to 41 polyhedral cores, chopper cores, edge cores, bipolar cores or other core tools (Kuman et al., 1997).

The hominid species most frequently represented at Kromdraai B, *P. robustus*, may have been victims of carnivore predation, and as at Swartkrans Members 1 and 2, the relatively low frequency of early *Homo* (generally less than 15%) may have been associated with the ability of these hominids to ward off carnivores, or at least to keep their distance from them.

The apparent absence of hominid fossils from KA could be interpreted to mean either that hominids such as early *Homo* were smart enough to avoid falling prey to carnivores (as at Swartkrans Member 3, pene-contemporaneous with KA), or that hominids at that time were simply avoiding the site which was used primarily by large carnivores, except at times when hominids with polyhedral cores attempted to access bone marrow from long bones of animals killed by those carnivores.

As yet there is no evidence for the use of fire at KA, contrasting with the situation at Swartkrans Member 3. Despite this difference, it is surprising that the degree of fragmentation (as reflected by MFL values) is relatively high at both Swartkrans (Members 1, 2, and 3) and at Kromdraai (KA and KB), and the carnivore-ungulate ratios for the same samples are so similar. The possibility that hominids were occasionally making use of these sites cannot be excluded. It would seem probable that hominids and carnivores may have competed for access to the caves.

Whereas the faunal sample from Sterkfontein Member 2 may have been associated primarily with a death-trap, accounting for the accumulation of many if not all of the mammalian remains, Member 5 is likely to have been associated with hominid activity.

As expected, carnivore:ungulate ratios for Late Quaternary assemblages are relatively low, confirming that samples from sites such as Wilton Rock Shelter, Bushman Rock Shelter, Apollo 11, Fackeltrager and Pomongwe were accumulated primarily by hominids (*Homo sapiens*) who consistently broke long bones for marrow as a source of protein. The high degree of fragmentation of long bone flakes as reflected by low mean flake lengths, and the relatively low standard deviations, are indicators of habitual bone breakage by Stone Age people. By contrast, the high carnivore:ungulate ratio obtained for the Swartklip assemblage at a site near Cape Town probably relates to hyenas as agents of accumulation (Klein, 1975).

This study indicates that mean flake lengths and carnivore:ungulate ratios can be used together cautiously to infer aspects of hominid behaviour, as part of the “big picture” which palaeoanthropologists and taphonomists attempt to portray from fragmentary remains. However, it would be necessary to include analysis of features such as percussion damage and tooth marking to test inferences based on CUR and MFL values. Unfortunately, in the case of some sites, it is difficult to examine bone damage in detail if the fossilized material in breccia has been prepared mechanically. The MFL and CUR values presented in this study serve primarily as a preliminary set of data of the kind which can be used to establish working hypotheses, which can themselves be tested by other taphonomic approaches.

As a working hypothesis it can be suggested that the cluster of data associated with Early Pleistocene assemblages from Kromdraai and Swartkrans (Figure 1) relates to scavenging by hominids as well as to carnivore activity. By contrast, the late Quaternary (LSA and MSA) data relate primarily to human behavior, associated with hunting and breakage of bone for marrow.

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