The Swartkrans Bone Tools

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Recent excavations at Swartkrans have produced 68 fossil bones that appear to have been used as digging tools, although some show subsequent modification through presumed use in the preparation of animal skins by early hominids.

INTRODUCTION

In the course of the excavations at Swartkrans between 1979 and 1986, a total of 68 fossil bones were found that appear to have been used as tools. Of these, 17 came from the Lower Bank of Member 1, 11 from Member 2 and 40 from Member 3. As mentioned in Chapter 1 of this volume, the Middle Stone Age unit designated Member 4 has not yet been excavated, while the excavated portions of Member 5 have not yielded any bone artefacts.

The typical feature of the Swartkrans bone tools is that they taper to smoothly worn points, with some of them showing a superimposed polish. The majority of the specimens consist of bone flakes, which have been defined (Brain, 1981) as coming from the shafts of long-bones, such as the femur, radius or metapodial, but lacking complete articular ends and not preserving more than half the circumference of the long-bone shaft; a smaller number are parts of antelopine horncores, while other skeletal parts are only marginally represented. When pondering about the possible use to which these bones had been put, it occurred to one of us (C.K.B.) that their worn appearance was very reminiscent of that of our excavation tools. In the softer parts of the Swartkrans deposit, as for instance the Lower Bank of Member 1, we used long screwdrivers to loosen the partially calcified sediment from quarter-metre grid squares, in 10 cm-deep spits. The loosened sediment was then loaded into buckets and carried to the sieve. When new, the screwdrivers had normal square ends, but after some days of use, these were modified into smoothly tapering points, with characteristic scratching, as shown in Fig. 1.

It seems likely that the only reason that early hominids would have had to dig in the ground, would be the procurement of food. Indeed, in the course of making a living on the open grassland habitat that appears to have existed around Swartkrans during the times of accumulation of Members 1, 2 and 3, it is very probable that hominids would have been obliged to augment their vegetable food with edible bulbs and other underground storage organs. An undisturbed dolomite environment, with some of its indigenous fauna, still exists about 15 km northeast of Swartkrans in the John Nash Nature Reserve on the farm Uitkomst. Observations made by one of us (C.K.B.) over many years on this reserve have shown that chacma baboons (Papio hamadryas ursinus) dig edible bulbs from dolomitic soil during the dry winter months when other vegetable food is less abundant than in summer. Two plants in particular were involved in these observations, Scilla (or Ledebouria) marginata and Hypoxis costata, the bulbs of which were dug out by baboons using only their hands, in situations where the ground was sufficiently soft for them to do this. Normally, such digging took place in the alluvium of valley bottoms and, although the plants in question are more abundant on the rocky dolomite hillsides, baboons are unable to excavate them there.

Lilies of the genus Scilla, or Ledebouria as it is usually now called, belong to the family Liliaceae and have decorative undulating leaves blotched with purple, up to 25 cm in length, and short inflorescences bearing purple and green flowers. The underground storage organ is a moisture-laden bulb, up to 20 cm in length and weighing up to 250 g (Fig. 2). Some species of Scilla are said to be poisonous to humans (Lucas, 1987), but they do not seem to cause harm to the Uitkomst baboons during the highveld winters.

'Grass stars' of the genus Hypoxis, belonging to the family Hypoxidaceae, have golden flowers, 2 cm or more in diameter, borne in inflorescences that are covered with silver or golden hairs. The leaves of H. costata are broad and sheath-like, fringed with long, rough hairs, and up to 20 cm long. A second species, H. rigidula, common on the Swartkrans hill, has narrow fibrous leaves, up to 60 cm in length, which used to be plaited into rope by indigenous people (Letty, 1962). The storage organs of Hypoxis plants are tunicated corms (Fig. 3), weighing up to 500 g, extremely fibrous and difficult to chew. Uitkomst baboons have been observed to eat them (C.K.B. personal observation), so it is possible that they were also used by early hominids.

It is clear that, if hominids had access to some sort of digging tools, they would have been able to use the food resource of Scilla, Hypoxis and other underground storage organs, unobtainable by baboons on the rocky dolomite hillsides. Their
The effect of digging on the appearance of metal tools – in this case, screwdrivers used as digging tools in the course of the Swartkrans excavation. The tool on the left is, as yet, unused, while the other two show characteristic wear and scratching reminiscent of that seen on the worn bones from Swartkrans described in this chapter.

Advantage over baboons in this regard, particularly during the dry winter months, must have been significant. The majority of bone tools found at Swartkrans, as mentioned above, are made on bone flakes and it may seem strange that these thin and sometimes delicate pieces should have been selected as digging tools, but the reason becomes obvious when one personally digs an edible bulb from a dolomite hillside, such as that at Swartkrans. The bulbs of *Scilla* and *Hypoxis* are typically 10-20 cm below the surface, but are wedged between and beneath a mosaic of angular chert blocks, which have to be removed one by one if the bulb is to be extracted whole. In order to remove a chert block, it is first necessary to scratch out the soil between it and adjacent blocks, after which it can usually be lifted out (Fig. 4). Experience has shown that the intervening soil can be best scratched out with a narrow, pointed instrument, such as is provided by a bone flake. In less rocky situations, a more robust tool such as an antelope horn is very effective.

Bone flakes can be generated from long-bone shafts either by the impact of a hammerstone on an anvil, or by the feeding of large carnivores, such as hyaenas. For the purpose of digging experiments, some bone flakes were collected at a blue wildebeest kill in the Kruger National Park that had been worked over by spotted hyaenas. These flakes, some of which are shown in Fig. 5, were between 8 and 12 cm long and were fresh at the time of collection. Two flakes were selected for a series of digging experiments at Swartkrans: Tool A was 105 mm long, with a maximum width of 25 mm, while Tool B was 82 mm long and 18 mm wide. Tool A had been used for a total of 8 hours digging at the time the photographs (Fig. 6a,b) were taken, while Tool B (Fig. 7a,b) had seen 4 hours’ service. It was found that noticeable smoothing of the sharp edges of the flakes was apparent after one hour of digging use, while rounding of the digging tip was well-developed after four hours of use. This rounding did not appear to be much accentuated in the subsequent four hours of digging to which Tool A was subjected, suggesting that the greatest visible modification of the original sharp edges had taken place within the first four hours of use. The length of time taken to dig a *Scilla* or *Hypoxis* bulb from the Swartkrans hillside varied from 14 to 30 minutes (*n* = 12), according to the stoniness of the ground.

The two experimental bone tools, together with the collection of fossil equivalents from Members 1, 2 and 3 at Swartkrans, were taken to the Department of Cell Biology and Anatomy of the Johns Hopkins University Medical School in Baltimore, during April 1987. Here selected parts of many of the speci-
A plant and tunicated corn of *Hypoxis costata*, dug from the Swartkrans hillside with an experimental bone tool shown in the photograph and also in Fig. 6.

Experimental use of a bone tool: Conrad Brain digs a *Hypoxis* plant out of the rocky Swartkrans hillside.

Mens were replicated, using silicone-based dental impression material to make negative impressions, in conjunction with epoxy resin used to make positive casts, according to the method described by Rose (1963). Scanning electron microscope photographs of the characteristic patterns of wear and scratching on experimental tools A and B are shown in Figs 6b and 7b, while those of selected Swartkrans fossil bone tools are provided with the descriptions of each specimen.

The microscopic patterns of wear on the possible bone tools from Swartkrans were compared with those resulting from use...
Bone flakes, broken from the limb bones of a blue wildebeest by spotted hyaenas. Naturally pointed flakes of this kind appear to have been selected by early hominids and used as digging tools in the vicinity of the Swartkrans cave.

on the experimental bone tools, to test the hypothesis that such use had caused the modifications that originally drew attention to the fossil specimens. Some specimens showed modifications that appeared to be functionally identical to those on the experimental digging tools; these are described and figured below. The use-wear on these specimens fulfilled expectations based on previous studies (Shipman, 1989; Shipman and Rose, 1988), in that the wear was confined to specific regions, immediately adjacent to the working edge or surface. Unaltered areas of bone could be observed a few millimetres away; these showed no traces of wear or modification. Other specimens were more ambiguous, showing modifications that could not be confidently distinguished from those produced by trampling, abrasion, weathering, carnivore digestion or other natural taphonomic processes. These were eliminated from the sample of bone tools, since it could not be demonstrated with confidence that the observed modifications were caused through use by hominids.

DESCRIPTONS OF SWARTKRANS BONE TOOLS

MEMBER 1 LOWER BANK

Horncore pieces used as tools

SKX 4228b, Fig. 8b.
Grid square. E5/N5, SW quarter; depth: 560–570 cm.
Date found. 9 July 1980.

Fig. 5

An experimental bone tool (A), based on a flake from a wildebeest limb bone. a: the tool showing wear resulting from eight hours of digging in the ground at Swartkrans. b: SEM image of the surface of the bone tool showing detail of scratching on the smoothly worn surface. Scale bar = 1 mm.

Description. A small tapering piece of bovid horn core, 43 × 15 mm, with smooth wear along two sides.
Interpretation. It is presumed to have been part of a much larger digging tool.

SKX 7068, Fig. 8a.
Grid square. E5/N4, SW quarter; depth 470–480 cm.
Date found. 19 March 1980.
Description. Parts of a fragmented bovid horn core with a smoothly worn tip. A distinct facet on one side of the tip suggests that the horn had an incomplete sheath on it when used. The horn core was at least 10 cm long before it was broken.
Interpretation. The smooth warn and scratching suggests that the horn had been used for digging and that the sheath-tip wore through to expose the end of the horn core.

SKX 5011, Fig. 9a,b.
Grid square. E3/N10; depth uncertain as the Member 1

Fig. 6

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Fig. 7
An experimental bone tool (B), based on a flake from a wildebeest limb bone. a: the tool showing wear resulting from four hours of digging in the ground at Swartkrans. b: SEM image of the surface of the bone tool showing detail of scratching on the smoothly worn surface. Scale bar = 1 mm.

sediment here had been disturbed by mining activities.

Date found: 25 March 1981.

Description. An almost complete horn core of a blesbuck, cf. Damaliscus dorcas, 145 x 30 mm, the distal 35 mm of which has been smoothly worn and polished.

Interpretation. SEM examination (Fig. 9b) confirms the visual impression that all sides of this horn core’s tip have been evenly worn, and that fine longitudinal scratches with occasional transverse ones, are visible under a smooth and even polish. It is inferred that the horn core was used as a digging tool, presumably without its sheath, and then used for rubbing soft material, perhaps animal skin.

Bone flakes apparently used as digging tools

SKX 794, Fig. 10a.

Grid square: E2/N3; depth: 350–400 cm.

Date found: 10 May 1979.

Description. The broken-off end of a bone flake, 28 x 20 mm,
smoothly worn and shows some scratching, although detail is partly obscured by adherent matrix.

**Interpretation.** Apparently the end of a digging tool that was originally much longer.

**SKX 1429, Fig. 10b.**
**Grid square.** E4/N3; depth: 500–550 cm.
**Date found.** 17 May 1979.
**Description.** The tip of a symmetrical worn point 18 × 8 mm, made on a bone flake. Longitudinal and transverse scratching is visible.

**Interpretation.** This appears to be the tip of a bone-flake digging tool which was originally much longer.

**SKX 3477/3478, Fig. 10c.**
**Grid square.** E4/N4, NE quarter; depth: 510–520 cm.
**Date found.** 28 February 1980.
**Description.** Two parts of a bone flake without a clear join, 41 × 16 and 18 × 27 mm respectively, tapering to a smooth and well-worn tip.

**Interpretation.** The smooth wear and scratching suggest that this bone flake, much longer when complete, was used as a digging tool.

**SKX 5003, Fig. 10d.**
**Grid square.** E4/N5, NW quarter; depth 660–670 cm.
**Date found.** 25 March 1981.
**Description.** A bone flake in four pieces, without clear joins, which had been at least 170 mm long when whole. The tip has been worn to a smooth conical point, showing fine longitudinal and transverse scratching.

**Interpretation.** An unquestionable digging tool made on a long-bone flake. Prolonged use, in excess of four hours, is indicated.

**SKX 5001, Fig. 10e.**
**Grid square.** E3/N4, NW quarter; depth: 610–620 cm.
**Date found.** 18 February 1981.
**Description.** A bone flake, 51 × 18 mm with a rounded and smoothly worn tip. Fine longitudinal and transverse scratching is visible.

**Interpretation.** A digging tool that was probably longer when used.

**SKX 5005, Fig. 11 a,b.**
**Grid square.** E3/N5, SW quarter; depth: 610–620 cm.
**Date found.** 11 February 1981.
**Description.** A rather flat bone flake, 100 × 20 mm, tapering to a symmetrical conical point. SEM detail of this point is shown in Fig. 11b, with prominent transverse scratches superimposed on smooth wear clearly apparent.

**Interpretation.** An exceptionally good example of a digging tool. The considerable wear suggests several days of use, implying that the tool was carried around for some time by its hominin owner.

**SKX 5006, Fig. 12a,b.**
**Grid square.** E3/N5, SE quarter; depth: 640–650 cm.
**Date found.** 18 March 1981.
Description. The tip of a bone flake, 35 x 13 mm, worn to a smooth, conical point. As shown in the SEM photograph (Fig. 12b), prominent longitudinal and transverse scratching is superimposed on the smoothly worn surface.

Interpretation. This specimen appears to be the tip of a bone-flake digging tool that was originally much longer.

SKX 5006, Fig. 13a,b.
Date found. 5 February 1981.
Description. A bone flake in three pieces, with imperfect joins, that would have been at least 150 mm long. The terminal 50 mm tapers to a smooth and symmetrical point, showing longitudinal and cross-scratches, some of which are visible in the SEM image in Fig. 13b.
Interpretation. Appears to be a typical example of a bone-flake digging tool.

SKX 5010a, Fig. 14a,b.
Grid square. E4/N9; depth about 1000 cm, in Member 1 sediment disturbed by lime-mining operations.
Date found. 19 May 1981.
Description. A bone flake, 85 x 15 mm, with a worn tip that is incomplete as a result of a longitudinal split. As shown in the SEM photograph (Fig. 15b), longitudinal and transverse scratching is superimposed on the smooth wear.
Interpretation. This is regarded as part of a larger bone-flake digging tool.

SKX 7052.
Grid square. E5/N4, SW quarter; depth: 460–470 cm.
SKX 5010a: a bone tool, assumed to have been used for digging, made on a bone flake from the Lower Bank of Member 1. a: the specimen; b: SEM detail of the worn tip showing fine linear scratching. Scale bar = 1 mm.

Date found. 19 March 1980.

Description. Part of a bone flake, 81 x 15 mm, tapering to a smoothly worn point. Longitudinal and transverse scratches are visible.

Interpretation. This appears to have been a digging tool on a bone flake that was originally longer and wider.

Bone flakes showing a high polish superimposed on wear and scratches

SKX 5000, Fig. 16a,b.
Grid square. E3/N5, SW quarter; depth 620-630 cm.
Date found. 11 February 1981.

Description. Three pieces of a bone flake, without good joins, indicating that the original piece of bone was at least 130 mm long. The largest piece, 62 x 25 mm, tapers to a very smooth and symmetrical point, showing scratching and pitting, over which is superimposed a surprisingly high polish (Fig. 16b).

Interpretation. It is suggested that this bone flake, which clearly tapered to a rough natural point, was used as a digging tool for a considerable period, and was then rubbed on some soft substance, such as animal skin.

SKX 5009, Fig. 17a,b.
Grid square. E3/N5, NE quarter; depth: 750-760 cm.
Date found. 10 June 1981.

Description. A piece of the tip of a bone flake, split longitudinally, 38 x 8 mm. The complete tip clearly tapered to a point, and what remains shows smooth wear with longitudinal and transverse scratches, on which a fairly high polish has been superimposed, as shown in the SEM photograph (Fig. 17b).

Interpretation. The specimen seems to have been part of a larger bone flake that had been used first for digging and then for rubbing some smooth substance, such as animal skin.

SKX 5012. Fig. 18a,b.
Grid square. E4/N9; depth: 1230 cm.
Date found. 3 June 1981.

Description. A thick bone flake, 113 x 25 mm, tapering to a chisel-like end, which shows smooth rounding and wear. Unidirectional scratching is visible beneath a well-developed...
polish, as shown in the SEM photograph (Fig. 18b).

**Interpretation.** It is possible that the bone flake was first used for digging, but thereafter it appears to have been used as a rubbing tool, perhaps for use on animal skin.

**MEMBER 2**

**Horncore pieces used as tools**

SKX 12383, Fig. 19a.

*Grid square. E4/S6, SE quarter; depth 80–90 cm.*

*Date found. 26 May 1983.*

*Description.* The distal end of a bovid horncore, 50 mm long and about 24 mm in diameter. The tip of the horncore had clearly broken off obliquely and the fractured surface has since been worn smooth with use. All surfaces of the piece show smooth wear, with some scratching visible on the roughly textured bone.

*Interpretation.* It is surmised that this horncore, when very much longer, was used as a digging tool and that, in the course of use, the tip was broken off. Further use then rounded the broken surface. It appears that the core was used without the original horn sheath in place.

SKX 15536, Fig. 19b.

*Grid square. E6/S1; depth: 150–200 cm.*

*Date found. 6 June 1979.*

*Description.* Two pieces of a broken horncore, 120 x 22 mm, the tip of which forms a smoothly tapering conical point. The natural point of the horncore has been blunted and worn with use, with wear visible up to 45 mm from the tip.

*Interpretation.* This was clearly part of a much longer horncore that appears to have been used as a digging tool. The smooth wear extending backwards from the tip suggests that the core was used without the covering sheath in place.

SKX 17211, Fig. 20a,b.

*Grid square. E4/S3, NE quarter; depth: 160–170 cm, at the
Fig. 18
SKX 5012: a bone tool made on a bone flake from the Lower Bank of Member 1, assumed to have been used both for digging and rubbing of animal skins. a: the specimen showing its blunt, chisel-like end; b: SEM detail of the worn end showing fine linear scratching on which polish is superimposed. Scale bar = 1 mm.

The interface between Member 2 and the underlying Lower Bank of Member 1.

Date found. 22 June 1983.

Description. The complete right horncore of an alcelaphine antelope of the genus Beatragus, 285 mm long and 55 mm in diameter at the base, with the tip worn off at right angles to the axis of the core. Smooth wear extends backwards from the worn tip for 15 mm on two laterally opposed surfaces. The surface of the rest of the horncore is not worn or polished.

Interpretation. It appears that this horncore, with its sheath in place, was used as a digging tool and that the sheath was worn back, exposing the truncated core. Furthermore, the sheath seems to have worn through on two opposing surfaces for a distance of about 15 mm from the end, exposing the core in these areas to smooth wear.

Bone flakes apparently used as digging tools

SKX 105, Fig. 21a,b.

Grid square. E5/S2; depth: 180–190 cm.

Date found. 26 July 1979.

Description. Tip of a bone flake, 36 × 13 mm, tapering to a smoothly worn and almost symmetrical point. Longitudinal and transverse scratches are visible, as in the SEM photograph (Fig. 21b).

Interpretation. The worn end of a once longer bone-flake digging tool.

Fig. 19
The tips of two antelope horncores from Member 2 that appear to have been used as digging tools: a: SKX 12383; b: SKX 15536.

Fig. 20
SKX 17211: a complete Beatragus horncore from Member 2 that appears to have been used as a digging tool. a: the whole specimen; b: detail of the worn tip.
Fig. 21
SKX 105: the tip of a bone-flake digging tool from Member 2. a: the specimen showing the well-worn point; b: SEM detail showing wear and scratches. Scale bar = 1 mm.

SKX 1142, Fig. 22a,b.
Grid square. E6/N1; depth: 175–200 cm.
Date found. 13 June 1979.
Description. The broken end of a fairly flat bone flake, 60 × 20 mm, with a symmetrically worn point. Prominent longitudinal scratching is visible, as shown in the SEM photograph (Fig. 22b).
Interpretation. The point of a once longer bone flake that had been used as a digging tool.

SKX 3227, Fig. 23a,b.
Grid square. E4/N4, SE quarter; depth: 460–470 cm.
Date found. 26 February 1980.
Description. Piece of a bone flake, 42 × 15 mm, with a smoothly worn tapering end. Coarse longitudinal and transverse scratching is visible, as shown in the SEM photograph (Fig. 23b).
Interpretation. The worn end of a once longer bone-flake digging tool.

SKX 10158/10159, Fig. 24a.
Grid square. E1/S7, SE quarter; depth: 100–110 cm.

Fig. 22
SKX 1142: part of a bone-flake digging tool from Member 2. a: the specimen showing its worn tip; b: SEM detail showing longitudinal scratching on the worn point. Scale bar = 1 mm.

Date found. 2 March 1983.
Description. Two pieces of a thick bone flake, without a clear join, that would have been at least 130 mm long. The tip piece, SKX 10158, 61 × 20 mm, tapers to an almost symmetrical bullet-shaped point, with smooth, even wear and some scratching.
Interpretation. Almost certainly a digging tool that has seen prolonged use.

SKX 16976, Fig. 24b.
Grid square. E4/N9; depth: 1200–1230 cm.
Date found. 3 June 1981.
Description. Piece of a transversely broken bone flake, 67 × 21 mm, that has also been split longitudinally. The shaft shows rodent gnawing, while the chisel-like tip has been smoothly worn and shows longitudinal and transverse scratches.
Interpretation. Appears to be part of a bone-flake digging tool that was subsequently gnawed by rodents, presumably after it had been discarded in the cave.
Bone flakes showing a high polish superimposed on wear and scratches

SKX 352, Fig. 25a,b.
Grid square. E5/N2; depth: 250–275 cm.
Date found. 21 June 1979.
Description. Part of the tip of a bone flake, 41 × 19 mm, that has been broken transversely and longitudinally. The tip shows smooth, rounded wear with scratching, superimposed on which is a high polish, as shown in the SEM image in Fig. 25b.
Interpretation. Initially a bone-flake digging tool, which has subsequently acquired a polish through being rubbed on soft material such as animal skin.

SKX 1141/1143, Fig. 26a,b.
Grid square. E6/N1; depth: 175–200 cm.
Date found. 13 June 1979.
Description. Two pieces of a bone flake that would have been at least 100 mm long. The tip piece, SKX 1143, 52 × 7 mm, tapers to a smoothly worn point, showing scratching on which is superimposed a high polish, as shown in the SEM image in Fig. 26b.

Fig. 23
SKX 3227: the end of a bone-flake digging tool from Member 2. a: the specimen showing its worn tapering tip; b: SEM detail of longitudinal and transverse scratches. Scale bar = 1 mm.

Bone flakes showing a high polish superimposed on wear and scratches

SKX 3227, Fig. 23: the end of a bone-flake digging tool from Member 2. a: the specimen showing its worn tapering tip; b: SEM detail of longitudinal and transverse scratches. Scale bar = 1 mm.

Fig. 24.
Parts of two bone-flake digging tools from Member 2. a: SKX 10158/9; b: SKX 16976.

Fig. 25
SKX 352: part of the tip of a bone flake from Member 2 that had apparently been used for digging and rubbing. a: the specimen; b: SEM detail showing polish superimposed on wear and scratches. Scale bar = 100 μm.
Fig. 26
SKX 1141/3: The tip of a bone-flake digging tool from Member 2 that appears to have served both for digging and rubbing. a: the specimen; b: SEM detail of the polished surface. Scale bar = 50 μm.

Interpretation. A bone-flake digging tool that has subsequently been used for rubbing, perhaps on animal skin.

SKX 3287, Fig. 27a,b.
Grid square. E4/N4, NE quarter; depth: 490–500 cm.
Date found: 26 February 1980.
Description. A complete bone flake, 130 x 25 mm, which tapered naturally to a chisel-like end. This shows even wear and rounding, as well as prominent scratching, on which is superimposed a high polish, as shown in the SEM image in Fig. 27b.
Interpretation. A bone-flake digging tool which has subsequently been used for rubbing soft material, such as animal skin.

MEMBER 3

Horncore pieces used as tools
SKX 21790, Fig. 28a.
Grid square. W3/S1, SW quarter; depth: 190–200 cm.

Date found. 15 March 1984.
Description. A complete left horncore of an unidentified antelope, including the frontal bone, 155 mm long. Smooth wear and rounding is visible on the distal 15 mm of the core, but not lower down.
Interpretation. It appears that the horncore, at that time still protected by its sheath, was used as a digging tool and that the tip of the sheath had worn away to expose the core, which suffered typical abrasion.

SKX 28768B, Fig. 28b.
Grid square. W3/S2, NE quarter; depth: 280–290 cm.
Date found. 14 February 1985.
Description. Four pieces of a somewhat curved horncore, probably from an alcelaphine antelope, that had an original length of at least 140 mm. The tip has been blunted by use and shows smooth wear and scratching.
Interpretation. The specimen appears to have been used for digging, but owing to the fragmentary nature of its distal end, it is uncertain whether it was with or without the sheath.
SKX 30246/9, Fig. 28c.
Date found. 7 March 1985.
Description. An almost complete right horncore, 120 mm long, probably of a springbuck, Antidorcas sp., with smooth wear and scratching round the tip, which has been blunted with use.
Interpretation. The horncore appears to have been used as a digging tool, while a certain amount of wear and polish on the shaft of the core suggests that it was used without its sheath.

SKX 23567, Fig. 29a.
Grid square. W2/S4, NW quarter; depth: 200–210 cm.
Date found. 1 August 1984.
Description. A small piece of horncore tip, 32 x 15 mm, with smooth wear and scratching.
Interpretation. Appears to be the tip of a horncore, which when more complete, had been used as a digging tool.

SKX 26234, Fig. 29b.
Grid square. W2/S5, NE quarter; depth: 270–280 cm.
Date found. 11 January 1985.
Description. The distal end, 45 x 12 mm, of a small, straight horncore from a steenbuck-like antelope, with smooth wear and scratching round the tip. The specimen has also, almost certainly, been burnt.
Interpretation. It appears that the horncore was used as a digging tool before being discarded close to a camp-fire in the cave, where it was subjected to a temperature of 300–400 °C.

SKX 28437, Fig. 29c.
Grid square. W3/S3, NE quarter; depth: 280–290 cm.
Date found. 14 February 1985.
Description. The distal end of a large horncore, 51 x 25 mm, which has been considerably modified by wear to a rounded point, showing polish and scratching.
Interpretation. The indication is that, when this horncore was complete, it saw prolonged use as a digging tool, apparently with its sheath on, which...
had worn away on one side more than the other.

SKX 30214/5, Fig. 29d.
Grid square. W3/S3, NE quarter; depth: 300–310 cm.
Date found. 27 February 1985.
Description. Two pieces from the distal end of a small horncore, but without a clear join. The terminal piece, $20 \times 11$ mm, has been worn to a blunt point, showing polish and scratching.
Interpretation. It appears that the horncore, when more complete, was used as a digging tool.

SKX 34570, Fig. 29e.
Date found. 24 July 1985.
Description. A small piece, $27 \times 12$ mm, of what appears to be horncore, worn to a smooth and symmetrical tapering point. Polish and scratching is visible.
Interpretation. This is clearly the tip of a much longer and well-used digging tool.

SKX 36485, Fig. 29f.
Grid square. W5/S3; depth: 550–600 cm.
Date found. 24 May 1985.
Description. A small piece, $30 \times 9$ mm, of horncore that has been worn to a smooth, bullet-like tip. Polish and scratches are visible and the piece looks as if it has been burnt.
Interpretation. It appears that this horncore, when much longer, was used for digging and was subsequently heated in a fire.

SKX 36861, Fig. 29g.
Grid square. W5/S2; depth: 600–650 cm.
Date found. 27 September 1985.
Description. A small piece, $25 \times 14$ mm, that has also been split longitudinally, from a horncore tip. It has been worn to a smooth, rounded end, with scratch marks.
Interpretation. Appears to be part of the tip of a horncore that had been used extensively for digging.

Horse mandible that had been used as a tool

SKX 29388 + 22747–22750 + 29171, Fig. 30a.
Date found. 20 February 1985.
Description. Left mandibular ramus of a mature three-toed horse, *Hipparion lybicum steytleri*, from Member 3. The ascending ramus has been broken off into a point (arrow) and appears to have been extensively used as a digging tool.

Interpretation. This appears to be part of the tip of a much longer digging tool that had been used extensively for digging, with the toothrow having been grasped in the hand. The amount of wear on the rounded point suggests that the tool saw extensive use, probably over several days.

Long-bone shaft piece apparently used as a digging tool

SKX 26324/8, Fig. 30b.
Grid square. W2/S5, SE quarter; depth: 300–310 cm.
Date found. 11 January 1985.
Description. A piece of antelope limb-bone shaft, $95 \times 30$ mm, one end of which had been fractured obliquely and then worn smooth. The worn surfaces show coarse scratching.
Interpretation. It seems that the naturally pointed end of this shaft piece had been used as a digging tool. The other end was very probably longer at the time of use.

Bone flakes apparently used as digging tools

SKX 10859, Fig. 31a.
Grid square. W6/S4; depth: 0–100 cm, found in a hole in the southwest wall of the cave.
Date found. 17 November 1982.
Description. The end of a large bone flake, $45 \times 20$ mm, that has also been split longitudinally. The tip shows considerable wear, resulting in smooth rounding with longitudinal and transverse scratching.
Interpretation. This appears to be part of the tip of a much longer digging tool that had seen fairly extensive use.
SKX 10978, Fig. 31b.
Grid square. W6/S4, depth: 0–100 cm. Date found. 7 November 1982.
Description. The end of a bone flake, 63 x 14, that has been worn into a tapering, bullet-like point. The smooth surface shows scratching and a certain amount of polish.
Interpretation. Almost certainly a digging tool that has seen prolonged use, extending over several days. The bone flake is likely to have been longer at the time of use, while the polish may indicate that it was also used for rubbing skins.

SKX 20046, Fig. 31c.
Grid square. W2/S5, NE quarter; depth: 200–210 cm. Date found. 17 November 1983.
Description. A bone flake, 87 x 29 mm, with a rounded, chisel-like tip, showing smooth wear, fine linear and occasional transverse scratching. Polish is likely to have been present but this is obscured by a superficial deposit of manganese dioxide.
Interpretation. Almost certainly a digging tool that may have been longer when used.

SKX 20081, Fig. 31d.
Grid square. W2/S5, SW quarter; depth: 210–220 cm. Date found. 16 November 1983.
Description. The end of a bone flake, 62 x 19 mm, tapering to a symmetrical and rounded tip. The smoothly worn surface shows linear and transverse scratching.
Interpretation. Almost certainly a digging tool, showing evidence of prolonged use. The bone flake may have been longer originally.

SKX 21617, Fig. 31e.
Grid square. W2/S5, NW quarter; depth: 220–230 cm. Date found. 16 November 1983.
Description. Part of a thick bone flake, 52 x 19 mm, broken transversely and longitudinally. What remains of the tip is chisel-like, showing smooth wear on three surfaces, with some polish.
Interpretation. The piece appears to have been part of a larger bone flake that had been used extensively for digging or rubbing skins.

SKX 22933a, Fig. 31g.
Description. Part of the tip of a bone flake, 25 x 13 mm, that has been broken transversely and longitudinally. The chisel-like tip shows smooth wear and abundant scratching.
Interpretation. This is almost certainly part of the tip of a digging tool, originally much larger, that has seen prolonged use.

SKX 25678, Fig. 31h.
Description. Part of the tip of a bone flake, 31 x 11 mm, that has been broken transversely and longitudinally. The rounded chisel-like tip shows smooth wear and scratching, beneath an encrustation of manganese dioxide.
Interpretation. This is almost certainly part of a digging tool that had been much larger when in use.

SKX 26112, Fig. 31i.
Grid square. W2/S3, SW quarter; depth: 170–180 cm. Date found. 16 March 1984.
Description. Part of a somewhat shattered bone flake, 93 x 32 mm, tapering to a smoothly worn bullet-like point. Scratching is clearly visible under an encrustation of manganese dioxide.
Interpretation. This is almost certainly a digging tool that has seen protracted use, extending over many days.
**Description.** Part of a bone flake, 49 x 17 mm, with an oblique chisel-like point that has been smoothed on all sides by wear and also shows scratching and polish.

**Interpretation.** This is the end of a bone flake that appears to have been used as a digging and/or a rubbing tool.

SKX 26138, Fig. 32b.

**Grid square.** W3/S2, NE quarter; depth: 210–220 cm.

**Date found.** 21 March 1984.

**Description.** The end of a fairly delicate bone flake, 47 x 11 mm, which tapers to a finger-like point that has been worn smooth on all sides. The smooth surface shows linear and transverse scratching.

**Interpretation.** The wear and scratching suggests strongly that this piece, though small, had been used for digging over an extended period.

SKX 26139, Fig. 32c.

**Grid square.** W3/S2, NE quarter; depth: 210–220 cm.

**Date found.** 21 March 1984.

**Description.** The end of a bone flake, 28 x 9 mm, that has been broken transversely and longitudinally. What remains of the tip shows that it tapered to a smooth, bullet-like point, showing even wear and scratching.

**Interpretation.** This is almost certainly part of a well-used digging tool, which originally consisted of a much longer bone flake.

SKX 26149, Fig. 32d.

**Grid square.** W3/S2, NE quarter; depth: 200–210 cm.

**Date found.** 21 March 1984.

**Description.** The end of a delicate bone flake, flat on one side but rounded on the other, which tapers to a smooth point. It shows even wear with fine linear, and occasional transverse, scratching.

**Interpretation.** The smooth wear and scratching suggests strongly that this was part of a longer digging tool, which must have been used over several days.

SKX 26624, Fig. 32e.

**Grid square.** W2/S5, NE quarter; depth: 280–290 cm.

**Date found.** 11 January 1985.

**Description.** The end of a bone flake, 51 x 27 mm, hemispherical in cross-section and tapering to a point in the form of a half-cone. The point shows smooth wear and fine scratching.

**Interpretation.** This is the end of a once longer bone flake that had, almost certainly, been used as a digging tool over an extended period.

SKX 28076, Fig. 32f.

**Grid square.** W3/S4, NE quarter; depth: 230–240 cm.

**Date found.** 23 January 1985.

**Description.** A pencil-like piece of bone flake, 51 x 9 mm, tapering to a rounded, symmetrical point.

**Interpretation.** The smooth wear and scratching suggests that this rather delicate tool was used for digging.

SKX 28487, Fig. 32g.

**Grid square.** W3/S3, NE quarter; depth: 230–300 cm.

**Date found.** 14 February 1985.

**Description.** The end of a bone flake, 35 x 11 mm, tapering to a symmetrical and rounded point, with smooth even wear and fine scratching.

**Interpretation.** When complete and much longer, this bone flake appears to have been subjected to prolonged digging.

SKX 28828, Fig. 32h.

**Grid square.** W3/S3, NE quarter; depth: 270–280 cm.

**Date found.** 14 February 1985.

**Description.** A small, flat bone flake, 43 x 14 mm, with a worn scoop-like end. The worn area shows scratching and polish.

**Interpretation.** The bone flake, when more complete, was almost certainly used for digging.

SKX 30052, Fig. 32i.

**Grid square.** W3/S4, NW quarter; depth: 320–330 cm.

**Date found.** 7 March 1985.

**Description.** The tip of a bone flake, 25 x 19 mm, with a well-worn symmetrical end, showing scratching and polish.

**Interpretation.** When much longer, this bone flake was almost certainly used as a digging tool.
SKX 30141, Fig. 33a.
Grid square. W3/S3, NW quarter; depth: 300-310 cm.
_Date found_. 7 March 1985.
_Description_. The end of a bone flake, 40 x 10 mm, that has been broken transversely and longitudinally. It shows smooth wear and scratching.
_Interpretation_. When more complete, this bone flake almost certainly saw prolonged use as a digging tool.

SKX 32582, Fig. 33b.
Grid square. W4/S2, NE quarter; depth: 230-240 cm.
_Date found_. 15 May 1985.
_Description_. A thin sliver of bone, 25 x 5 mm, which has split longitudinally from the tip of a bone flake, and which tapered to a smoothly worn point. What remains of the worn surface shows fine scratching.
_Interpretation_. When complete, this bone flake had almost certainly been used for digging.

SKX 32897, Fig. 33c.
Grid square. W4/S2, SE quarter; depth: 270-280 cm.
_Date found_. 21 May 1985.
_Description_. The end of a bone flake, 49 x 9 mm, which could be a piece of rib split longitudinally, and which has been worn to a symmetrical point. The smoothly worn surface shows fine scratching.
_Interpretation_. Although delicate, this specimen appears to have been extensively used as a digging tool.

SKX 33654, Fig. 33d.
Grid square. W3/S2, SW quarter; depth: 420-430 cm.
_Date found_. 29 May 1985.
_Description_. A thick and rather flat bone flake, 71 x 14 mm, tapering to a smoothly worn and bullet-like point. Despite a coating of manganese dioxide, longitudinal and transverse scratching is visible.
_Interpretation_. This is almost certainly a digging tool that has been extensively used over a number of days.

SKX 35196, Fig. 33e.
Grid square. W4/S2; depth: 470-550 cm.
_Date found_. 8 August 1985.
_Description_. A thin, flat bone flake, 57 x 15 mm, one end of which is worn to a smoothly rounded spatulate tip showing linear and occasional transverse scratching.
_Interpretation_. Almost certainly a digging tool that has been extensively used.

SKX 37703, Fig. 33f.
Grid square. W3/S3; depth: 550-600 cm.
_Date found_. 28 September 1985.

SKX 38041, Fig. 33g.
Grid square. W5/S4; depth: 660-700 cm.
_Date found_. 11 October 1985.
_Description_. A long-bone flake, 131 x 22 mm, one end of which has been worn to a symmetrical and rounded point that shows linear scratching and a certain amount of polish.
_Interpretation_. Almost certainly a digging tool that has seen prolonged use over a number of days.

SKX 38830, Fig. 33h.
Grid square. W3/S1; depth: 70 cm, on north wall of the Member 3 gulley.
_Date found_. 23 October 1985.
_Description_. A bone flake, 86 x 19 mm, one end of which is pointed as a result of a diagonal break. This point has been worn smooth and shows scratching.
_Interpretation_. This naturally pointed bone flake has almost certainly been used for digging.
Description. A small piece, 24 x 10 mm, from the tip of a bone flake that has had its natural point rounded by wear. Scratching is visible despite an encrustation of manganese dioxide.

Interpretation. When much longer, this bone flake was almost certainly used for digging.

A delicate bone flake fashioned into an awl-like tool

SKX 37052, Fig. 34a,b.

Grid square. S3W3; depth: 610–620 cm.

Date found. 26 September 1985.

Description. A delicate bone flake, 58 x 6 mm, tapering at one end to a sharp point that has been considerably worn. Its smooth surface shows fine linear scratching and a fairly high polish, as shown in the SEM image in Fig. 34b.

Interpretation. This delicate bone flake is unlikely to have been used as a digging tool. Its fine linear scratching and polish suggests rather that it was used for piercing softer material, such as animal skin.

DISCUSSION

Although the number of bone tools found at Swartkrans is small in relation to the total number of fossil bone pieces from the relevant Members, there appears to be a fairly even scatter of these tools throughout the excavated areas and depths.

In the Lower Bank of Member 1, 17 bone tools have been described out of a total of 52 496 bone pieces from animals larger than the ‘microfauna’ assumed to have been collected largely by owls. This gives a figure of 0.032 % for the incidence of bone tools in Member 1 Lower Bank. It is interesting to note that only two bone tools have so far been found in the sediment of the Hanging Remnant of Member 1, the probable reason for this being discussed in Chapter 13.

In Member 2, 11 bone tools have been described out of a total of 34 312 bone pieces, which gives the same percentage incidence as for Member 1 Lower Bank, namely 0.032. The situation in Member 3 is interestingly different, however, with 40 bone tools having been found among a total of 63 125 bone pieces, giving a percentage incidence
Fig. 36

A reconstruction by Imogen Berry showing a group of Swartkrans hominids digging edible bulbs from the ground. One of them has a carrying bag made on an animal skin for the transport of tools and gathered foods. The use of such containers is suggested by the bone tools found in Swartkrans Members 1, 2 and 3.

of 0.063, or approximately double that for the earlier two Members.

It is of interest to compare the abundance of bone artefacts in the three Swartkrans Members with that of stone artefacts:

<table>
<thead>
<tr>
<th>Stratigraphic unit</th>
<th>Number of bone tools</th>
<th>Number of stone artefacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member 1 (Lower Bank)</td>
<td>17</td>
<td>402</td>
</tr>
<tr>
<td>Member 2</td>
<td>11</td>
<td>403</td>
</tr>
<tr>
<td>Member 3</td>
<td>40</td>
<td>72</td>
</tr>
</tbody>
</table>

A curious fact emerges from these figures – that Member 3 contained far fewer stone artefacts that the earlier two units, but appreciably more bone tools. It should be remembered that Member 3 is the deposit containing evidence for early fire-making, in the form of burnt bones distributed throughout the vertical profile (see Chapter 10, this volume). The Member 3 bone tools occur in close association with burnt bones and two of the tools show evidence of having been in a camp-fire (SKX 26234, 26485, both burnt horncore pieces). Within the excavated area of the Member 3 gulley, burnt bone pieces have been found in 17 grid squares, while ten of these have also provided bone tools, suggesting that the fire-tending hominids were also the users of the bone tools.

As is apparent from the descriptions and interpretations of individual bone tools earlier in this chapter, all but one of the 68 tools appear to have been used for digging in the ground, although some have been modified by subsequent rubbing. Of the 67 presumed digging tools, 49 show evidence of prolonged use, almost certainly in excess of one day, and probably extending over many days, if not weeks. The question arises as to how the Swartkrans early hominids managed to keep bone, and possibly stone artefacts, in their possession for days or weeks at a time, without losing them in the course of their daily food-seeking rounds. An obvious answer would be that these hominids had access to carrying bags in which their tools, and possibly their gathered foods, were transported.

As detailed in the descriptions of the individual bone tools, three specimens from each of the three Members show a polish superimposed on the wear and scratching which, originally, appears to have been caused by digging. The suggested interpretation is that the digging tools had been used also for rubbing a soft substance, presumably animal skin. Of interest in this regard is the description of a bone tool by Robinson (1959) from his excavation of Sterkfontein Member 5. The tool, SE 612, is shown in Fig. 35a, while SEM detail of the polished surface is given in Fig. 35b. Made on a bone flake with a natural
point, the tool has a well-defined worn facet, showing fine linear scratching and a high polish. Robinson's interpretation was that the bone had been repeatedly rubbed on a soft substance, presumably animal hide, a conclusion with which we concur, although the original use of the tool, resulting in general wear on the tip, may have been digging. Ethnographic bone tools used in hide-burnishing, or working of other soft substances, show a fine polish (Shipman and Rose, 1988; Olsen, 1984), similar to that seen on the Sterkfontein and Swartkrans polished bone tools.

Another bone tool, from Swartkrans Member 3, is suggestive of use on animal hides. It is the delicate awl-like artefact SKX 37052, shown in Fig. 34a, b, which consists of a thin flake of bone tapering to a worn point showing longitudinal and circumferential scratching, together with polish. This tool may well have been used for piercing holes in skins or other soft materials, as similar microscopic wear has been documented on experimentally made and used awls (Olsen, 1984). The evidence discussed here suggests that the Swartkrans hominids of Member 1–3 times may well have made simple carrying bags from animal skins, as well as possibly their gathered food. This could explain the evidence for the apparent use of the same tools over successive days or weeks. The evidence also emphasizes the importance of food-procurement by digging during the daily life of these hominids on the open grassland environments of Southern Africa, an activity portrayed in the reconstruction by Imogen Berry shown in Fig. 36.

A study has been made by one of us (P.S.), using the same techniques as those described in this chapter, of bone tools from Olduvai Gorge (Shipman, 1989). Points of interest are that minimally shaped bone tools also occur at Olduvai between two and one million years ago. These comprise a small percentage of the total bone assemblage, ranging from 0.2 to 2.0 % at various sites. If the assemblages of 32 373 bones, excluding unidentifiable fragments, from Beds I and II at Olduvai are combined, then the 41 confirmed bone tools make up 0.13 % of the total. If the Bed II assemblage only is considered, the bone tools comprise 0.5 % of the total, while the increase in the incidence of bone tools in Bed II mirrors the increase seen at Swartkrans as one passes from Member 2 to Member 3. Some of the Olduvai bone tools, like their counterparts at Swartkrans, show wear suggestive of use on soft animal skins, while others appear to have been anvils, which might have been used in the working of skins, and which occur with stone awls. However, the type of bone from which the Olduvai tools are made is different, with a strong bias towards very large animals, while the apparent use to which the tools were put was also different, with very few having been used for digging.

REFERENCES


The Incidence of Damage Marks on Swartkrans Fossil Bones from the 1979–1986 Excavations

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A sample of 147 311 fossil bone pieces from Members 1, 2, 3 and 5 at Swartkrans was examined for the presence of naturally occurring damage marks. Such marks were classified as tooth scratches, punctures, chewed edges, rodent-gnawed bones, insect borings and digested bones. A listing of the specimens showing damage attributable to the above categories is provided. Cut marks were also noted on some specimens but these are not dealt with here. Epoxy replicas of selected specimens were made and examined with a scanning electron microscope.

INTRODUCTION

The usefulness of damage marks on bones in the taphonomic reconstruction of fossil assemblages has been appreciated for a long time (e.g., Shipman, 1981; Bunn, 1981; Potts and Shipman, 1981). In view of this, it was decided to examine a large sample of fossil bone pieces from the most recent Swartkrans excavations for the presence of carnivore feeding-marks and other recognizable traces. It proved to be easy to separate recent damage marks, such as those resulting from excavation or fossil preparation, from pre-fossilization marks.

Three categories of carnivore-damaged bone were recognized: tooth scratches, punctures and chewed edges; two of rodent gnawing; one of insect boring and one of digested bone pieces. The sample used consisted of 147 311 fossil bone pieces from four Swartkrans Members: Member 1, Lower Bank: 52 496 specimens; Member 2: 34 312 specimens; Member 3: 40 239 specimens and Member 5: 20 264 specimens. Each specimen was individually examined for the presence of damage marks attributable to one of the categories mentioned above and 1038 pieces were selected for further study. These specimens were examined in greater detail under a stereo microscope and, in many cases, replicas of the damaged surfaces were made for study with a scanning electron microscope.

TOOTH SCRATCHES

Shipman (1981: 365) provided the following definition: ‘A tooth scratch is produced by drawing a pointed tooth cusp across the surface of a bone as the animal closes its mouth. This type of mark is probably most often made by carnivores’ canines. Tooth scratches are elongate grooves that may vary from V-shaped to U-shaped in cross-section, depending on the morphology of the tooth cusp. The bottom or nadir of the groove is smooth. Tooth scratches may occur on bones singly, as sets of parallel and sub-parallel marks, or as clusters of marks differing widely in orientation.’

Marks conforming to this description were observed on 311 specimens, as detailed below:

Member 1, Lower Bank

A total of 66 specimens, made up as follows: Bovid size class II (as defined in Brain, 1981). Right astragalus, SKX 9809; left proximal metatarsal, SKX 15417. Miscellaneous. Rib fragments, SKX 8726, 9265, 11977, 47012; unfused proximal humeral head, SKX 21315; femoral epiphysis, SKX 28357. Bone flakes (as defined in Brain, 1981). Fifty two pieces of the following lengths: 1–2 cm, 1; 2–3 cm, 9; 3–4 cm, 12; 4–5 cm, 9; 5–6 cm, 9; 6–7 cm, 5; 7–8 cm, 3; 8–9 cm, 3; 11–12 cm, 1. Indeterminate fragments. 6.

Member 2

A total of 47 specimens, made up as follows: Bovid size class I. Mandibular coranoid process, SKX 46924;
metapodial shaft, SKX 3809.

Bovid size class II. Left proximal metacarpals, SKX 696, 45852; right femur shaft, SKX 1153; right humeral piece, SKX 2264.

Miscellaneous. Femoral head, SKX 15309; epiphysis fragment, SKX 15541.

Bone flakes. Thirty three pieces of the following lengths: 1-2 cm, 5; 2-3 cm, 1; 3-4 cm, 10; 4-5 cm, 6; 5-6 cm, 4; 6-7 cm, 2; 7-8 cm, 2; 8-9 cm, 1; 10-11 cm, 1.

Indeterminate fragments. 5.

Member 3
A total of 103 specimens, made up as follows:

Damaliscus sp. Left horncore base, SKX 36309.
Canis mesomelas. Right proximal ulna, SKX 30498.
Procavia antiqua. Left distal humerus, SKX 36086.
Cercopithecoid indet. Left humeral fragment, SKX 19495; right distal humeral fragment, SKX 37838.

Bovid size class II. Right and left pelvic pieces, SKX 27008, 35245; phalanx piece, SKX 29955; calcaneus fragment, SKX 31362.

Bovid size class III. Calcaneus fragment, SKX 31606; right distal humerus, SKX 32346; right distal radius, SKX 34904; left proximal radius, SKX 37135; proximal metatarsal, SKX 37586.

Bovid size class IV. Immature distal metapodial, SKX 28671; left calcaneus, SKX 29880.

Aves, cf. francolin. Tarsometatarsal spur, SKX 37691.

Miscellaneous. Skull fragments, SKX 31600, 19684; horn core fragment, SKX 22042; rib fragments, SKX 21989, 28096; femoral pieces, SKX 30525, 33566, 33381, 26895; proximal humeral pieces, SKX 26562, 33451.

Bone flakes. Fifty pieces of the following lengths: 2-3 cm, 7; 3-4 cm, 11; 4-5 cm, 15; 5-6 cm, 6; 6-7 cm, 5; 7-8 cm, 4; 8-9 cm, 1; 9-10 cm, 1.

Indeterminate fragments. 25.

Member 5
A total of 96 specimens, made up as follows:

Equus burchelli. Left proximal ulna fragment, SKX 41194.
Procavia capensis. Pelvic fragment, SKX 41591/5; right proximal femur, SKX 42038.
Procavia transvaalensis. Left proximal ulna, SKX 43466.

Bovid size class I. Left proximal metacarpal, SKX 41856; femoral shaft, SKX 47262.

Bovid size class II. Scapula piece, SKX 42128; left distal radius, SKX 40599; left proximal radius, SKX 41292; radial shaft piece, SKX 44188; distal humeral pieces, SKX 41286, 44428, 44893; humeral shaft pieces, SKX 41769, 41610; distal femoral pieces, SKX 42337, 42687; femoral shaft pieces, SKX 42369, 42597; left distal tibia, immature, SKX 42647; calcaneus pieces, SKX 41526, 42412, 44385, 47237; astragalus piece, SKX 44448; proximal metatarsals pieces, SKX 41939,
DAMAGE MARKS ON FOSSIL BONES

42644; distal metatarsal piece, SKX 44797; proximal metacarpal pieces, SKX 42642, 42646, 44898; distal metacarpal piece, SKX 41943; metapodial shaft pieces, SKX 44821, 45240, 47231; phalanx pieces, SKX 42398, 45354, 47799. Bovid size class III. Left distal humerus, SKX 42336; pelvic fragment, SKX 44471. Miscellaneous. Scapula piece, SKX 43594; rib fragments, SKX 42991, 43797; femoral pieces, SKX 47343, 47353. Bone flakes. Thirty nine pieces of the following lengths: 1-2 cm, 3; 2-3 cm, 3; 3-4 cm, 10; 4-5 cm, 9; 5-6 cm, 6; 6-7 cm, 5; 7-8 cm, 1; 8-9 cm, 1; 10-11 cm, 1. Indeterminate fragments. 12.

PUNCTURES (Figs 3, 4)

Shipman (1981: 366) provided the following definition:

"Punctures are produced by the concentration of a biting force through a single tooth cusp, often a canine, at an angle roughly perpendicular to the bone surface. The result is a depressed fracture with rounded, roughly circular outline. In some cases, microscopic fragments of bone can be seen pushed inwards into the surface. Punctures may have a stepped appearance because the area of depression is greatest at the bone surface and decreases as the distance from the surface increases."

Marks conforming to this description were observed on 74 specimens, as detailed below.

Member 1, Lower Bank

A total of 12 specimens, made up as follows:

Procavia antiqua. Right proximal femoral piece, SKX 5803. Bovid size class III. Cervical vertebral piece, SKX 8842. Miscellaneous. Vertebral fragment, SKX 5830; left astragalus, SKX 6703, and rib fragment, SKX 8091. Bone flakes. Five pieces of the following lengths: 2-3 cm: 1; 3-4 cm, 1; 4-5 cm, 3. Indeterminate fragments. 2.
Member 2
A total of five specimens, made up as follows:

- **Bovid size class II.** Juvenile distal tibia piece, SKX 2262.
- **Bovid size class III.** Right distal radius, SKX 2042.
- **Miscellaneous.** Vertebral fragment, SKX 1128; humeral fragments, SKX 3413, 3732.

Member 3
A total of 20 specimens, made up as follows:

- **Bovid size class II.** Right scapular piece, SKX 39840; juvenile distal femur shaft, SKX 37385; right proximal ulna, SKX 39984.
- **Bovid size class III.** Scapular fragment, SKX 19587; carpal, SKX 31910.
- **Bovid size class IV.** Radial shaft, SKX 28742.
- **Suid indet.** Femoral fragment, SKX 38618.
- **Miscellaneous.** Vertebral pieces, SKX 25433, 25880, 33509, 35261, 35563, 37848, 39983; femoral pieces, SKX 28910, 33159.
- **Indeterminate fragments.** 4.

Member 5
A total of 37 specimens, made up as follows:

- **Antidorcas bondi.** Left mandibular fragment, SKX 42542.
- **Procavia capensis.** Left distal tibia, SKX 43812.
- **Bovid size class I.** Humeral fragment, SKX 42837; proximal radial fragment, SKX 43354.

### CHEWED EDGES (Fig. 5)

The diagnostic feature of this category of damage is that the specimen's features have been altered by the removal of bone, inwards from an edge or surface. An irregular or ragged edge normally results, similar to that seen on bones chewed by carnivores.

Marks conforming to this description were observed on 267 specimens, as detailed below:

**Member 1, Lower Bank**
A total of 53 specimens, made up as follows:

- **Bovid size class I.** Scapular piece, SKX 11976; metacarpal, SKX 6877.
DAMAGE MARKS ON FOSSIL BONES

Fig. 4
Scanning electron microscope images of puncture marks on Swartkrans fossil bones. a: SKX 46995 from Member 1 Lower Bank; b: SKX 47121a from Member 1 Lower Bank; c: SKX 31910 from Member 3; d: SKX 47635 from Member 5.

Bovid size class II. Proximal humeral fragment, SKX 8464; distal humeral pieces, SKX 6276, 8055, 11939a; humeral shaft, SKX 17230; pelvic piece, SKX 8720; distal metapodials, SKX 9016, 21084; phalanx, 9359.

Bovid size class III. Distal humeri, SKX 4162, 6397; proximal metapodial, SKX 47040; juvenile distal metapodial, SKX 14803.

Aves indet. Distal tibio-tarsal piece, SKX 8485a.

Miscellaneous. Cranial fragments, SKX 7949, 8457; rib fragments, SKX 5679c, 6456, 6779; scapular piece, SKX 4312; pelvic piece, SKX 17248; proximal humeral pieces, SKX 4852, 8012; proximal femoral piece, SKX 9048.

Bone flakes. Twenty one pieces of the following lengths: 2–3 cm, 2; 3–4 cm, 6; 4–5 cm, 5; 6–7 cm, 4; 7–8 cm, 2. Indeterminate fragments. 6.

Member 2
A total of 21 specimens, made up as follows:

Bovid size class III. Left proximal humerus, SKX 2043; tibial fragment, SKX 3435; calcaneus, SKX 15933.

Miscellaneous. Skull condyle, SKX 3159; vertebral fragment, SKX 46923; humeral epiphysis, SKX 991.

Bone flakes. Thirteen pieces of the following lengths: 2–3 cm, 3; 3–4 cm, 4; 4–5 cm, 3; 5–6 cm, 2; 9–10 cm, 1. Indeterminate fragments. 2.

Member 3
A total of 74 specimens, made up as follows:

Equus capensis. Proximal phalanx, SKX 28313.

Procavia antiqua. Left ulna, SKX 38048.

Cercopithecoid indet. Immature left mandible piece, SKX 27988.

Lagomorph indet. Left distal femur, SKX 38003.
Examples of Swartkrans fossils showing chewed edges. Member 1 Lower Bank: SKX 8055, SKX 6276; Member 2: SKX 2043; Member 3: 22743; Member 5: SKX 44074.

Bovid size class I. Skull condyle, SKX 37749; left scapular piece, SKX 39080; pelvic fragments, SKX 33616; humeral pieces, SKX 19555, 25841, 27648, 29840; radial shaft, SKX 39015; astragalus, SKX 27608, 29701, 30721, 28740; calcaneus, SKX 32320; patella, SKX 22072; phalanx, SKX 30783.

Bovid size class II. Pelvic pieces, SKX 22743, 36310; distal humerus, SKX 27762; right proximal ulna, SKX 28479; left femur head, SKX 36610; left astragalus, SKX 38559; metapodial fragment, SKX 26932; carpal, SKX 27831.

Miscellaneous. Vertebral fragments, SKX 22973, 32297; rib fragment, SKX 33255; femoral fragment, SKX 31489; calcaneus, SKX 37749; phalanx, SKX 25450.

Bone flakes. Twenty eight pieces of the following lengths: 2-3 cm, 1; 3-4 cm, 6; 4-5 cm, 7; 5-6 cm, 9; 6-7 cm, 2; 7-8 cm, 1; 8-9 cm, 1; 10-11 cm, 1.

Indeterminate fragments. 9.

Member 5

A total of 119 specimens, made up as follows: Equus burchelli. Immature right distal tibia, SKX 41192.

Bovid size class II. Left mandibular pieces, SKX 40651, 42541; atlas vertebral fragment, SKX 43306; axis vertebral fragment, SKX 41474; lumbar vertebrae, SKX 41355; sacral fragments, SKX 42268, 42951; scapular pieces, SKX 40608, 40613, 40617, 40745, 41056, 41064, 41279, 41609, 41638, 41684, 41819, 42111, 42143, 42331, 42379, 42413, 42470, 42851, 42856, 43273, 43283, 43876, 43892; pelvic pieces: SKX 40598, 40601, 40606, 40658, 41283, 42273, 42348, 42474, 42491, 43894; humeral shafts, SKX 41284, 41340; distal humeral pieces, SKX 41554, 42328, 42698, 44074, 47300, 41550; left proximal ulna, SKX 45017; right femoral head, SKX 42391; distal femoral pieces, SKX 41626, 47329, 41554, 45178, 44430; right proximal tibia, SKX 43884; calcaneus, SKX 45048.

Bovid size class III. Pelvic piece, SKX 47338; scapular piece, SKX 45075; pelvic piece, SKX 41850; femoral fragment, SKX 43163.

Bovid size class IV. Mandibular fragment, SKX 41398.

Miscellaneous. Skull fragments, SKX 40691, 41470, 41899, 42881, 42910; vertebral fragments, SKX 40668, 41615, 41639, 42954, 43572, 43716, 43917, 44075, 44681; rib fragments, SKX 41608, 43415; scapular fragments, SKX 40655, 41835, 43253, 43344, 44446; pelvic fragments, SKX 41837, 42446, 40690, 42923, 42931, 43984, 44512, 44865; proximal humeral fragments, SKX 45384, 47316; proximal femoral fragment, SKX 41639; proximal tibial fragment, SKX 43913; phalangeal fragment, SKX 43914.

Bone flakes. Fourteen pieces of the following lengths: 4-5 cm, 2; 5-6 cm, 5; 6-7 cm, 3; 7-8 cm, 1; 8-9 cm, 2; 9-10 cm, 1.

Indeterminate fragments. 8.
PORCUPINE-GNAWED BONES (Figs 6, 8a)
Marks caused on bones by the gnawing of porcupines are highly characteristic, resulting in the reduction of skeletal elements to distinctively-shaped cores (Maguire, 1976; Brain, 1981). Porcupines gnaw bones to wear down their constantly growing incisors and to augment their phosphate intake. The gnaw marks result from the drawing of the upper and lower incisors over the surface of the bone being gnawed. The marks are shallow, flat-bottomed scoops, each the width of the porcupine’s incisors.
Such marks were observed on 46 specimens, as detailed below.

Member 1, Lower Bank
A total of eight specimens, made up as follows:
Miscellaneous. Vertebral fragment, SKX 38479.
Bone flakes. Four pieces of the following lengths: 2–3 cm, 1; 4–5 cm, 2; 5–6 cm, 1.
Indeterminate fragments. 3.

Member 2
A total of 12 specimens, made up as follows:
*Hipparion lybicum steytlerti*. Left distal metatarsal III, SKX 453.
*Bovid size class III*. Scapular fragment, SKX 12388.
Bone flakes. Nine pieces of the following lengths: 2–3 cm, 1; 3–4 cm, 1; 4–5 cm, 2; 5–6 cm, 2; 6–7 cm, 1; 7–8 cm, 1; 11–12 cm, 1.
Indeterminate fragment. 1.

Member 3
A total of 26 specimens, made up as follows:
*Hipparion lybicum steytlerti*. Right distal metacarpal III, SKX 22936.
*Bovid size class III*. Right astragalus fragment, SKX 38251.
*Bovid size class IV*. Right calcaneus, SKX 22651.
Bone flakes. Twelve pieces of the following lengths: 2–3 cm, 1; 3–4 cm, 5; 4–5 cm, 1; 5–6 cm, 2; 9–10 cm, 1; 12–13 cm, 1; 15–16 cm, 1.
Indeterminate fragments. 11.

Member 5
None found.

SMALL-RODENT-GNAWED BONES (Figs 7, 8b)
The marks in this category are similar to those on porcupine-gnawed bones, but are made by the incisors of mouse- and rat-sized rodents. Individual marks resemble vertical-sided grooves, more than the shallow scoops of porcupine-gnawed bone.
Such marks were observed on 141 specimens, as detailed below:
Member 1, Lower Bank
A total of 14 specimens, made up as follows:
*Bovid size class II*. Left proximal metatarsal, SKX 14597; 1st phalanx, SKX 14670.
*Miscellaneous*. Tooth fragment, SKX 4677; rib fragment, SKX 47062; carpal, SKX 9416.
*Bone flakes*. Seven pieces of the following lengths: 2–3 cm, 2; 3–4 cm, 2; 4–5 cm, 1; 5–6 cm, 2.
*Indeterminate fragments*. 2.

Member 2
A total of 12 specimens, made up as follows:
*Procavia antiqua*. Right mandibular fragment, SKX 665.
*Bovid size class II*. Phalanges, SKX 403, 3130.
*Bovid size class IV*. Right proximal radial fragment, SKX 294.
*Miscellaneous*. Tooth fragment, SKX 45939.
*Bone flakes*. Five pieces of the following lengths: 2–3 cm, 1; 3–4 cm, 2; 4–5 cm, 1; 6–7 cm, 1.
*Indeterminate fragments*. 2.

Member 3
A total of 15 specimens, made up as follows:
*Bovid size class II*. Pelvic piece, SKX 26921.
*Bovid size class III*. Left distal humerus, SKX 38509.
*Hyaenid indet*. Right ulna shaft, SKX 36657; 1st phalanx, SKX 32397.
*Miscellaneous*. Vertebra fragment, SKX 27076; rib fragment, SKX 36432.

Member 5
A total of 102 specimens, made up as follows:
*Antidorcas bondi*. Right mandibular fragment, SKX 41424.
*Procavia capensis*. Right mandibular piece, SKX 41226.
*Bovid size class I*. Right humeral shaft fragment, SKX 43911.
*Bovid size class II*. Atlas vertebral fragment, SKX 41844; scapular pieces, SKX 41838, 42484; humeral pieces, SKX 41120, 41298, 42372, 42748; left proximal ulna, SKX 42666; distal femoral pieces, SKX 42686, 42697; femoral shaft pieces, SKX 41531, 43181; tibial pieces, SKX 40599, 42592; tarsal bone fragment, SKX 45367; proximal metacarpals, SKX 41536, 41537, 45204; proximal metatarsal, SKX 41320; metapodial pieces, SKX 41782, 42609; astragali, SKX 42872, 44859; calcaneus pieces, SKX 43404, 47330, 47803; phalanges, SKX 40605, 40638, 42414, 42426, 42891, 44370.
*Bovid size class III*. Sternum fragment, SKX 42749.
*Aves indet*. Tarsometatarsus, SKX 42865.
*Miscellaneous*. Mandible pieces, SKX 42704, 41380; rib fragments, SKX 40976, 47453; scapular fragments, SKX 41868, 41949, 43278, 47378; radial shaft, SKX 42176; metapodial pieces, SKX 43122, 41535.
*Bone flakes*. Forty five pieces of the following lengths: 1–2 cm, 8; 2–3 cm, 10; 3–4 cm, 11; 4–5 cm, 8; 5–6 cm, 3; 6–7 cm, 4;
DAMAGE MARKS ON FOSSIL BONES

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Fig. 8
Scanning electron microscope images of gnawing marks on Swartkrans fossil bones. a: porcupine gnawing marks on SKX 47030 from Member 1 Lower Bank; b: small rodent gnawing marks on SKX 42484 from Member 5.

7–8 cm, 1.
Indeterminate fragments. 9.

INSECT-BORED BONES (Fig. 9)
As shown in Fig. 9, bones in this category show circular holes, penetrating into the specimen, either at right angles or obliquely to the surface. The holes vary in diameter from two to five millimetres and may penetrate for up to one centimetre. Walls of the tunnels are typically smooth and their bases are rounded. In some cases there is a raised lip around the periphery of the hole. It is surmised that the smaller of these holes and tunnels were made by termites, while the larger examples were the work of beetle or moth larvae.

Marks conforming to this description were observed on 41 specimens, as detailed below.

Member 1, Lower Bank
A total of 19 specimens, made up as follows:
Bovid size class II. Phalanx, SKX 8336.
Bovid size class III. Humeral pieces, SKX 11899, 45410; tibial pieces, SKX 45392, 45409; phalanges, SKX 45504, 45659.
Bovid size class IV. Distal metapodial, SKX 14300.
Miscellaneous. Horncore fragment, SKX 5271b.
Bone flakes. Five pieces of the following lengths: 1–2 cm, 1; 2–3 cm, 1; 4–5 cm, 1; 7–8 cm, 1; 9–10 cm, 1.
Indeterminate fragments. 5.

Member 2
A total of eight specimens, made up as follows:
Bovid size class II. Phalanges, SKX 3972, 1245, 3417.
Bovid size class III. Right astragalus, SKX 3988.
Miscellaneous. Ulna shaft, SKX 726.
Bone flakes. Two pieces of the following lengths: 3–4 cm, 1; 4–5 cm, 1.
Indeterminate fragment. 1.

Member 3
A total of nine specimens, made up as follows:
Gazella sp. Horncores, SKX 29281, 36311.
Bovid size class I. Right distal femur shaft, SKX 36480.
Bovid size class II. Phalanges, SKX 26897, 27263.
Bovid size class III. Right distal femoral piece, SKX 36304.
Miscellaneous. Horncore fragments, SKX 29791, 39829; femoral fragment, SKX 32611.
Indeterminate fragment. 1.

Member 5
A total of four specimens, made up as follows:
Bovid size class II. Right distal femur, SKX 42653; left proximal tibia, SKX 42664.
Indeterminate fragments. 2.

DIGESTED BONES (Fig. 10)
Digested bones (hardly ever exceeding six centimetres in length) are assumed to have been swallowed by a carnivore, affected by the digestive juices, and then either regurgitated or voided with the droppings. They typically show an overall rounding of sharp edges, etching or polishing.

In all, 156 bone pieces conforming to this description were found, as detailed below.

Member 1, Lower Bank
A total of 92 specimens, made up as follows:
Bovid size class II. Astragalus fragment, SKX 6575.
Miscellaneous. Rib fragment, SKX 13680; humeral shaft fragment, SKX 6310; tooth fragments, SKX 4659a, 4890, 5785, 18056.
Bone flakes. Seventy one pieces of the following lengths: 1–2 cm, 27; 2–3 cm, 33; 3–4 cm, 8; 4–5 cm, 3.
Indeterminate fragments. 14.

Member 2
A total of 28 pieces, made up as follows:
Bovid size class II. Left patella, SKX 2765.
Miscellaneous. Pelvic fragment, SKX 231; distal femoral condyle, SKX 1097; phalanx, SKX 46938.
Fig. 9
Examples of Swartkrans fossils showing insect boring. Member 1: SKX 45409, SKX 45410.

Bone flakes. Twenty two pieces of the following lengths: 1–2 cm, 3; 2–3 cm, 14; 3–4 cm, 3; 4–5 cm, 2.
Indeterminate fragments. 2.

Member 3
A total of 23 pieces, made up as follows:
Bovid size class I. Right radial carpal, SKX 48437.
Bone flakes. Eleven pieces of the following lengths: 1–2 cm, 1; 2–3 cm, 3; 3–4 cm, 5; 5–6 cm, 2.
Indeterminate fragments. 11.

Member 5
A total of 13 pieces, made up as follows:
Miscellaneous. Skull fragment, SKX 42897.
Bone flakes. Twelve pieces of the following lengths: 1–2 cm, 4; 2–3 cm, 4; 3–4 cm, 4.

DISCUSSION
Carnivore-induced marks and their implications
As detailed above, marks attributed to carnivore feeding activity have been described under the headings 'tooth scratches,' 'punctures' and 'chewed edges.' The incidence of these marks relative to the entire sample is shown in Table 1. The incidence of carnivore-induced damage marks shows that carnivores, presumably both predators and scavengers, were involved in the bone-accumulating process in Members 1, 2, 3 and 5. The assemblages from Members 1 and 2 show approximately the same percentage incidence of damage marks (0.25 and 0.21). The figure for Member 3 is appreciably higher (0.49), while it is higher still in Member 5 (1.24). While these incidence figures indicate unquestionable carnivore involvement in the history of the bone assemblages, the percentages are remarkably low. Blumenschine (1988) showed that, in an experimental assemblage worked over by spotted hyaenas, an average of 15% of long-bone fragments showed distinctive tooth marks. However, most of the individual Swartkrans fossil specimens are small pieces, presumably a result of breakage caused by trampling and weathering, while they were exposed on the cave floor before fossilization. To this must be added the damaging effects of excavation and removal from the matrix, which applies to assemblages from all the Members studied. It was noticeable, however, that the individual fossil specimens from Member 3 tended to be more complete than those from Members 1 and 2, while fossil bones from Member 5 were the most complete of all, although they were often noticeably weathered.

On the basis of the observed damage marks, it is very difficult to be sure of the identity of the carnivores involved. Damage marks consistent with those caused by both leopards and hyaenas were seen.
Implications of porcupine-gnawed bones

It is well known that porcupines (*Hystrix africaeaustralis*) collect large numbers of bones in their retreats and breeding lairs and that they gnaw them there. The incidence of gnawed bones in a porcupine-collected assemblage will vary according to the availability of bones in the home range of the porcupines involved, while the incidence has been shown to vary from 22 to 100% in different porcupine lairs (Brain, 1981).

Porcupine-gnawed bones were found in the fossil assemblages from Members 1, 2 and 3, though they were absent from the Member 5 sample. However, the numbers were extremely small: eight for Member 1; 12 for Member 2; and 26 for Member 3. This indicates that porcupines did make use of the cave during the accumulation periods of these Members, but their contribution to the building up of the assemblages was almost insignificant.

Implications of small-rodent-gnawed bones

It is not unusual to find bones in Southern African caves that have been gnawed by rodents of mouse- or rat-size. This indicates that these rodents either live in the caves or visit them, while their reasons for gnawing bones are presumably the same as for porcupines, i.e., the need to wear their incisors and to augment their phosphate intake. It is unlikely that such small rodents were instrumental in bringing bones to the caves, but they simply modified those bones they encountered on the cave floors.

As detailed above, 143 small-rodent-gnawed bones were found in the assemblages examined, individual numbers being as follows: Member 1, 14; Member 2, 12; Member 3, 15, and Member 5, 102. These figures indicate that mice or rats, of unknown identity, occasionally gnawed bones on the cave floor during the accumulation periods of the four Members studied. They were clearly much more active in the case of
Member 5 than in the others, although the absence of porcupine-gnawed bones in this assemblage suggests that the Member 5 depositional space, or 'Bondi channel' as it is called, was inaccessible or unattractive to porcupines, but that this was not true for smaller rodents.

**Implications of insect-bored bones**

Little can said about the fact that 41 fossil bones in the collections examined had been bored by insects, either termites or the larvae of moths or beetles. Such insects were obviously occasionally active on the floor of the cave during the accumulation periods of all Members investigated.

**Implications of digested bones**

The presence of digested bones on a cave floor suggests that the cave was frequented by carnivores that either regurgitated the bones or voided them with their droppings. The most likely carnivores to be involved in a contemporay Southern African context are leopards or brown hyaenas.

Of the 156 bone fragments considered to have been digested, 92 occurred in Member 1, 28 in Member 2, 23 in Member 3, and 13 in Member 5. The carnivores responsible left these traces either inside the cave, or within the catchment area of its entrance.

**CONCLUSION**

This study of the occurrence and incidence of damage marks on Swartkrans fossil bones suggests that carnivores, probably hyaenas and large cats, were involved in the bone-accumulating process of all the assemblages examined. The role of porcupines appears to have been negligible.

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**REFERENCES**


