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Although 74 years have elapsed since the discovery at Taung of the first *Australopithecus* fossil, and despite intensive fieldwork in East Africa and 32 years of non-stop excavation at Sterkfontein, there has not been a discovery to date of a reasonably intact skull and associated skeleton of an ape-man. This is an account of the extraordinary series of events that led to just such a discovery and a preliminary assessment of the significance of the fossil, which is still largely embedded in the Member 2 breccia of the Sterkfontein Caves near Krugersdorp, South Africa.

Between 1936 and 1947, Robert Broom, later assisted by John Robinson, recovered numerous fossil remains of *Australopithecus* and other fauna from the ancient infilling of the Sterkfontein Caves. A subsequent programme of excavation, initiated in 1966 by P.V. Tobias under the field direction of Alun Hughes, greatly enlarged the sample of *Australopithecus* fossils from these deposits, which are estimated to be older than 2.6 Myr[1] and which Partridge[2] defined as Member 4 of the Sterkfontein Formation.

In 1978, Tobias decided that it was time to investigate the lower and older Members 2 and 3 of the Sterkfontein Formation, which were exposed in the Silberberg Grotto named after Dr H.K. Silberberg, who, around 1942, had collected from there part of the fossilised upper and lower jaw of *Chasmoporthetes*, the Pliocene hunting hyaena.[3,4]

This fossil was found in a block of breccia among piles of other fossil-bearing breccia blocks left on the floor of the cavern by lime workers, who, in the 1920s or early 1930s, had blasted away a huge stalagmite boss. The removal of the boss left Member 3 forming the upper north wall of the cavern, the dolomite cave wall forming the south wall, and Member 2 forming a steep talus slope dipping to the west, with a densely fossiliferous layer to the east.

Access to the floor of the cavern from the surface excavation site was provided in 1978 by Randfontein Estates Gold Mine, who installed wooden steps and a winch platform. Hughes then organised the removal to the surface of the lime workers' dump of breccia blocks and rubble from the cave floor. The bones were subsequently cleaned out of the breccia by technicians at Sterkfontein and labelled with various dates between 1978 and 1980 and 'D20' for 'Dump 20', sorted and stored. The bulk of the collection, consisting of cercopithecoid fossils, was stored in the Department of Anatomy, University of the Witwatersrand (Wits), while two boxes of sundry fossil fragments were stored in the workshed at Sterkfontein.

The first hominid from Member 2

By 1992, Tobias was anxious to see more fossils extracted from the oldest deposits and, accordingly, we selected an appropriate place for excavation at the fossil-rich eastern end of the Silberberg Grotto. Because of the solid nature of the deposit and the fact that we had to excavate into a vertical wall, we enlisted the help of John Cruise and Dusty van Rooyen, who, on 26 October 1992, blasted out a large sample of breccia that proved to be rich in carnivore and cercopithecoid fossils. I was puzzled by the paucity of bovid fossils and went to check, on 6 September 1994, for bovids in the two boxes stored in the Sterkfontein shed. To my astonishment, I identified among the miscellaneous foot bones of bovids, carnivores and primates, first a talus, then the navicular, medial cuneiform and proximal half of the first metatarsal of one hominid left foot. I also found what looked like a badly damaged hominid lateral cuneiform that was morphologically incompatible with the left foot and a fragment of what I thought was possibly hominid calcaneum but could not be certain. The four other foot bones were a revelation in that they represented not only the oldest hominid from Sterkfontein but also revealed ape-like as well as human characteristics and, in particular, included a first metatarsal that had a somewhat mobile joint with the medial cuneiform, indicating the probability that this particular ape-man (catalogued as StW 573) spent at least some time in the trees, as well as on the ground.

The vital clue

On 15 May 1997, I chanced to open a cupboard in our hominid strong room at Wits Medical School to extract some fragments of the hominid StW 53 that I knew to be there, when I noticed a box labelled 'D18 Cercopithecoids'. I found that it also contained D20 cercopithecoids and, as I was interested in these monkeys from the Silberberg Grotto, I removed the box to study the contents. The following Monday, 19 May, I had time to study the fossils and, to my delight, when I extracted the first polythene bag, I spotted through the plastic a tell-tale white bone that was clearly a hominid intermediate cuneiform that fitted with the medial cuneiform of StW 573. Next, in the same box, I found the left lateral cuneiform, the proximal end of the left second metatarsal and the left distal fibula. On 21 May, in another bag, I found what proved to be a vital clue in the chain of events, the disto-medial portion of a hominid tibia. It did not fit perfectly with the StW 573 talus, but I assumed that this was because it was only the medial portion and was slightly damaged.

Since the oblique break across the shaft looked as if it could have happened during the miners' blasting, I decided to look for a tibia shaft among the two boxes of miscellaneous Dump 20 fragments at Sterkfontein. On 27 May, in a bag labelled as bovid tibiae, I found a shaft, with the distal end intact, of what was clearly a hominid tibia, and it fitted perfectly with the left talus of StW 573. Then I realised that the other distal tibia fragment was from the right leg of the same individual. In this light, I checked again the damaged, supposed cuneiform that I had noted earlier and found that it was indeed a mirror image of the left lateral cuneiform that I had just found. I now had part of the right foot of the same individual. I also found in a bag labelled 'Dump 20, Bovid Humeri' at Sterkfontein a heavily damaged chunk of bone that I identified as part of a hominid calcaneum. When I checked it against the previous fragment that I had thought was calcaneum, they fitted together. The smaller fragment formed part of the articular surface for the cuboid and, significantly, it was bowl-shaped, like that of a chimpanzee, indicating mobility, whereas that of a human has a notch that receives a keel on the articular surface of the cuboid in order to provide greater stability. Here was yet another indication of the of ape-like morphology of the StW 573 foot, complemented by the three cuneiforms that were also more ape-like than human.

I now had a total of 12 foot and lower leg bones of one ape-man individual — the left

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Fig. 1. Foot bones ancient and modern. Below scale: StW 573 left tibia, fibula and foot bones. Above scale, left to right: right distal tibia fragment and lateral cuneiform, cast of the articulated left lower leg and foot bones of StW 573, and a Bushman left lower leg and foot bones.

tibia and fibula, which joined to an articulated set of eight foot and ankle bones, and the distal fragment of a right tibia and right lateral cuneiform (Fig. 1). On 11 June 1997, I announced this new discovery[6,7] — the implication was stunning: I stated my conviction that the rest of the skeleton was still encased in the cave breccia of the Silberberg Grotto.

Prophesy fulfilled

At the end of June 1997, I gave a cast of the distal fragment of the right tibia to two of the Sterkfontein fossil preparators, Nkwane Molefe and Stephen Motsumi, and asked them to search the exposed breccia surfaces in the entire Silberberg Grotto (except for the area we had recently blasted) to find a matching cross section of bone for which this would provide an exact fit (Fig. 2). The task I had set them was like looking for a needle in a haystack as the grotto is an enormous, deep, dark cavern with breccia exposed on the walls, floor and ceiling. After two days of searching with the aid of hand-held lamps, they found it on 3 July 1997, near the bottom of the Member 2 talus slope at the western end of the grotto. This was at the opposite end to where we had previously excavated. The fit was perfect, despite the bone having been blasted apart by lime workers 65 or more years previously. To the left of the exposed end of the right tibia could be seen the section of the broken-off shaft of the left tibia, to which the lower end of the left tibia with foot bones could be joined. To the left of that could be seen the broken-off shaft of the left fibula. From their positions with the lower limbs in correct anatomical relationship, it seemed that the whole skeleton had to be there, lying face downwards.

Molefe, Motsumi and I soon began to excavate, using hammers and chisels for the bulk of the breccia, the travertine and dolomite blocks, while I used a small hammer and chisels for the breccia close to the fossils. As I proceeded to excavate upslope, I uncovered the left tibia shaft and the distal ends with lower shafts of the left and right femurs, which were slightly displaced and in reversed positions relative to the tibiae. Next to a large dolomite block I uncovered, between 1 and 5 May 1998, a complete left radius on the right side of the skeleton, and to the right of the right tibia was the distal end of the right fibula (Fig. 3).

To our consternation, upslope of the broken-off shafts of the femurs, we found nothing more, despite removing, slowly and carefully, a large volume of breccia and big blocks of dolomite that had to be broken with chisels into smaller pieces. Because of the natural relationship of the two lower legs and the completeness of the delicate

Fig. 2. The author, Ron Clarke (centre), with Stephen Motsumi (left) and Nkwane Molefe, who is holding the cast of the distal tibia fragment that led them to discover the skeleton.

radius, logic demanded that the rest of the skeleton and skull should be there. By early September 1998, after we had carefully exposed more of the strata, I realised what had happened: there had been an ancient collapse of the part of the breccia immediately upslope of the broken femur shafts and that this collapsed portion had been subsequently covered by thick travertine. I asked Motsumi to chisel away the very hard, thick travertine down to the breccia and then I selected a small area and asked him to remove the breccia carefully, and telephone me if he found bone. This he did the very next day, 11 September. It turned out that his chisel had made a direct hit on the distal end of a hominid humerus that was positioned almost vertically right next to another bone. By 17 September, when I had cleaned enough of that bone, it proved to be an ape-man mandible that was attached to its cranium. These were situated about 62 cm upslope and to the left of the distal end of the right femur. Further cleaning has revealed a so-far intact left side of an ape-man skull with upper and lower dentition in occlusion (Fig. 4). This discovery indicates that the pelvis, vertebrae and other limb bones are probably still within the breccia at a lower level between the skull and the lower parts of the femurs.

Fig. 3. The parts of the StW 573 skeleton so far exposed. At bottom centre is the cast of the back of the left tibia and fibula with foot pointing into the breccia. At right centre is the right tibia with the cast of the distal end attached (note the excellent join). The visible part of the shaft is 19 cm long. At top centre are the right distal femur on its side and the anterior face of the left distal femur, which has been displaced to the right side. At top right is the left radius. The position of the skull, which would not be seen from this angle, is beyond the top left corner of the photograph.

Significance of the discovery

The skull remains embedded in very hard breccia containing numerous dolomite and chert stones that are in many cases right against the bone; the face is in close proximity to a large dolomite block. Until the skull is more fully exposed, it is not possible to say anything about its exact taxonomic status or whether it is male or female. We can, however, state that it is a mature adult with a massive zygomatic arch (unlike known crania of *Australopithecus africanus*) and a temporal line that encroaches far sagittally onto the low frontal squamae. It does not fall obviously into the morphology of known Member 4 hominids. Although the skull and radius seem to have unusual characteristics, I prefer to reserve judgement on the fossil's exact taxonomic affinities, although it does appear to be a form of *Australopithecus*. It is worth recording, even at such a preliminary stage, that this is not only the most complete *Australopithecus* skull ever discovered, but it is associated with the most complete ape-man foot and the most complete tibia, radius and humerus.

The taphonomic situation and age

The skull and postcranial elements recovered so far indicate that the whole skeleton lay on the talus slope, which, in addition to breccia containing large and small dolomite and chert blocks, has layers of reddish sediment, dark brown mud flows and travertine flows. Other fossils are virtually absent in the vicinity of the skeleton, with the exception of an occasional small fragment of bone of other fauna. This contrasts with the Member 2 deposit at the eastern end of the cavern, which has a dense concentration of bones and skulls, including partial skeletons of monkeys and carnivores.[8] This raises the question of how such an intact hominid skeleton came to be in that isolated spot within the cavern.

The situation of the skull sealed beneath the thick travertine that separates Members 2 and 3, and the 6.5 m depth of Member 3, indicate that a great span of time elapsed between the deposition of Members 2 and 4, and that Member 2 is thus probably older than 3 Myr, perhaps as old as 3.5 Myr.[1]

Furthermore, it is noteworthy that Turner's analysis of a *Chasmoporthetes* partial skull from the Member 2 east deposit

Fig 4. Left side of the StW 573 ape-man skull partially excavated from the breccia. The distal end of the left humerus is seen against the back of the ascending ramus of the mandible at right, and the humeral shaft, only partly exposed, is pointing downwards.

did not identify it as *Chasmoporthetes silberbergi*, previously recorded from there, but indicated a possible link with the much earlier lower Pliocene *Chasmoporthetes australis* from Langebaanweg.[9]

Conclusion

No matter what kind of ape-man StW 573 turns out to be, the discovery of this skull with its skeleton provides us with a wealth of potential information on the anatomy, locomotor behaviour and evolution of an early hominid. It offers a fascinating taphonomic puzzle coupled with insights into stratigraphic problems in dolomite caves. It demonstrates the important role that Sterkfontein and South Africa have to play in the understanding of human ancestry.

Alun Hughes used to tell me of a recurrent dream that he had of his breaking into a cavern and finding a complete skeleton of an *Australopithecus* lying there. I am pleased that, through strange circumstances, it has been my good fortune to realise Alun's dream and to bring to fruition the expectations of Phillip Tobias, that an archaic form of *Australopithecus* would be recovered from the lowest levels of Sterkfontein.

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