

# Male philopatry and female dispersal amongst two species of early hominins from the Sterkfontein valley

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An article by Sandi Copeland and colleagues,<sup>1</sup> which appeared in *Nature* on 02 June 2011, strongly suggests that amongst two species of early hominins that were present in the Sterkfontein Valley, the male individuals were much less likely to disperse from their natal group than the female individuals. The two species were *Australopithecus africanus* from Sterkfontein and *Paranthropus robustus* from nearby Swartkrans. The ranges on the landscape of the male and female fossil specimens were determined by measuring the strontium isotope ratios in their tooth enamel and comparing the results with those from the geological substrate of the Sterkfontein Valley. Most of the male specimens had lived in the area from birth (thus male philopatry), whilst a substantial number of the female specimens had come from somewhere else.

All the cave sites that have yielded hominin fossils in the Cradle of Humankind occur in the Malmani dolomite formation. These sites include Sterkfontein, Swartkrans, Kromdraai, Makapansgat and Drimolen. The Malmani dolomite is a relatively narrow formation on the landscape, running from south-west to north-east for more than 60 km, but with a width of only 7 km – 9 km. From the cave sites of Sterkfontein and Swartkrans, the formation extends about 2 km – 3 km to the south-east and 5 km – 6 km to the north-west.

The <sup>87</sup>Sr/<sup>86</sup>Sr ratio of the Malmani dolomite ranges between 0.721 and 0.734. All of the plants that grow on the dolomite and the elements of the food chain that are based on them have the same strontium isotope ratios.<sup>2</sup> Their mean value differs significantly from nine nearby geological substrates and overlaps with only two, which are quite small. The teeth of the hominins incorporate the strontium isotope ratios of the geological substrate during the first eight years of life and can thus be identified as being local or non-local in origin.

Darryl de Ruiter selected from the collections of the Transvaal Museum (now the Ditsong National Museum of Natural History) 19 tooth crowns of early hominins for analysis. Of these 19, 8 were specimens of *Australopithecus africanus* from Sterkfontein Member 4, dating from ~2.2 Ma (million years ago) and 11 were specimens of *Paranthropus robustus* from Swartkrans Member 1 (~1.8 Ma). The tooth sizes of each species were compared with all the specimens of the same species from Sterkfontein, Swartkrans, Kromdraai, Makapansgat and Drimolen. The teeth could be separated into male and female specimens, based on the sexual dimorphism of these early hominins. For both species, the body weight of male individuals has been estimated at about 40 kg and that of female individuals at about 30 kg.<sup>3</sup> The teeth of the male specimens, therefore, are significantly larger than those of the female specimens.

By way of comparison, the strontium isotope ratios in the teeth of 38 fossil mammals from Sterkfontein and Swartkrans, of the same age as the hominins, were also measured. These fossil mammals were from taxa with small home ranges, such as *Procapra* (rock hyrax) and *Raphiceros* (steenbok), as well as some monkeys, baboons and bovines. To place the ranges of the hominins and other mammals in the context of biologically available strontium,<sup>4</sup> 170 modern plant and animal specimens were collected by several members of the team within a 50 km radius of Sterkfontein and Swartkrans, covering 11 different geological substrates.

The <sup>87</sup>Sr/<sup>86</sup>Sr ratios of the tooth enamel specimens were measured using a New Wave UP213 laser ablation unit, coupled to a NuPlasma high-resolution multicollector inductively coupled mass spectrometer (LA-MC-ICP-MS). This instrument is located at the Africa Earth Observatory Network (AEON) at the University of Cape Town (UCT), to which it was granted by the Department of Science and Technology, and it is operated by geochemist Petrus le Roux. The plant specimens were dried and ashed in the Department of Archaeology at UCT and their strontium isotope ratios measured by solution MC-ICP-MS at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, where Copeland is currently located.

Laser ablation MC-ICP-MS is less accurate than solution MC-ICP-MS,<sup>5</sup> but it has the advantage that it is essentially non-destructive, leaving only small traces (200 µm × 750 µm) on the enamel



Curator Stephany Potze examines a fossil hominin tooth after laser ablation (Photo: Julia Lee-Thorp).

surface of a tooth. However, LA-MC-ICP-MS requires that the tooth be brought to the instrument. The fossil teeth from the collections of the Transvaal (Ditsong) Museum cannot be taken out of the control of the curators. This problem was solved when curator Stephany Potze, accompanied by the museum's information officer Tercia Perrigil, flew to Cape Town with the specimens and observed the laboratory work. Potze graciously declined the offer of co-authorship, because '... I am only doing my job'. The  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios of the fossil mammals from Sterkfontein and Swartkrans show that very few are non-locals. Of the Cercopithecidae (monkeys), 1 out of 7 specimens were non-locals, as were 1 of 11 Procaviidae (rock hyraxes) and 3 of 19 Bovidae. Of the 19 hominins, 6 were non-local and 4 of these had tooth sizes below the mean for their given species. At least 50% of the small hominins were non-local, but only 11% of the large hominins were. One can conclude that the male hominins lived where they were born, whilst the female hominins were likely to have arrived from somewhere else. This example of male philopatry is exhibited by many groups of modern humans and also by *Pan* (chimpanzees).<sup>6</sup> Amongst gorillas, however, both male and female individuals disperse at similar rates.<sup>7</sup> The authors think it unlikely that there is a modern analogue for the male philopatry of the early hominins, given that the low sexual dimorphism of their canine teeth indicate relatively low competition amongst the male hominins.

The importance of this study lies in the fact that sophisticated new technology was used to determine the behaviour of early hominins. The demonstration that male individuals stayed where they were born and female individuals

moved towards them is not in itself of major importance. Chimpanzees do the same and so do my farming relatives in the Karoo. In the case of modern farmers, this has to do with farms that are inherited by sons and wives that are recruited from somewhere else. In the case of the Sterkfontein Valley, the caves in the dolomite may have been the draw card, but this is a matter of interpretation.

The study has already received attention in the scientific literature,<sup>8</sup> but especially so in the popular press, where the response has ranged from serious to funny. An interesting example is the article titled 'Cavegirls rule, OK!' by Paul Harris and Fiona Macrae in the *Daily Mail* of 06 June 2011. It is illustrated with an image of a scantily clad Racquel Welch on a poster reading 'Was this the way it was one million years BC?' I have no comment on the ruling cavegirl theme, but I do on a statement in the article that the findings were '... made by Oxford University researchers and an international team of scientists'. Although funded by the US National Science Foundation, three of the eight authors are South Africans (Julia Lee-Thorp, Daryl Codron and Le Roux). Sponheimer completed his PhD at Rutgers University, but was trained in isotope work by Lee-Thorp at UCT; Lee-Thorp also trained Codron and De Ruiter, a Canadian who did his PhD at the University of the Witwatersrand. Lee-Thorp, formerly a member of the UCT Archaeology Department and now Professor of Archaeological Science at Oxford, comments that the study could not have been done without the LA-MC-ICP-MS facility at AEON, the fossil collections in the Transvaal Museum and the considerable help of the curators.

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