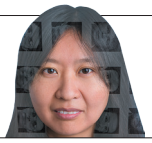
NEWS IN FOCUS



PATRICK LANDMANN/SCIENCE PHOTO LIBRARY

The unique skeleton was embedded in rock deep inside a South African cave.

ARCHAEOLOGY

'Little Foot' fossil chiselled out of stone yields secrets

Mysterious ancient hominin retrieved after 20-year effort might be a distinct species.

BY COLIN BARRAS

After a tortuous 20-year-long excavation, an ancient skeleton is starting to reveal new information about early human evolution. The first of a raft of papers about 'Little Foot' suggests that the fossil is a female who showed some of the earliest signs of human-like, bipedal walking, around 3.67 million years ago. She might also belong to a distinct species unfamiliar to most researchers. "It's almost a miracle it's come out intact," says Robin Crompton, a musculoskeletal biologist at the University of Liverpool, UK, who collaborated with the research team that excavated the skeleton.

The nickname Little Foot, echoing the mythical 'Bigfoot', refers to the small foot bones that were among the first parts of the skeleton to be discovered. In 1994, Ronald Clarke, a palaeoanthropologist at the University of the Witwatersrand (Wits University) in Johannesburg, South Africa, was rifling through boxes of fossils at a field laboratory at the Sterkfontein caves, about 40 kilometres northwest of Johannesburg. He realized that a handful of small bones in the collection belonged to a species of *Australopithecus* — ape-like hominins in Africa between about 4 million and 2 million years ago, before the human genus *Homo* rose to dominance[1].

Clarke and his colleagues then found more bones embedded in a matrix of solid rock deep in the caves. They began carefully excavating Little Foot, piece by fragile piece, using hammers and chisels followed by precision tools. "The fossilized bone is actually softer than the matrix," says Crompton. "It's been an ▶

absolute devil to get it out."

By late last year, Clarke's team had removed enough bones to reconstruct more than 90% of the skeleton — making it the most complete *Australopithecus* so far. On 29 November, they posted two papers on Little Foot to the bioRxiv preprint server — one on the age of the specimen[2], the other on the limbs and locomotion[3].

On 4–5 December, the team posted third and fourth papers, on the skull and the potential relationship of the specimen to a known hominin species[4], as well as on the arms and an injury Little Foot received during her life[5]. Further papers, on the hand, teeth and inner ear, are expected in the near future, says Crompton. Most will ultimately appear in a special edition of the *Journal of Human Evolution*.

A NEAR-COMPLETE PUZZLE

The bioRxiv papers crystallize ideas that emerged in earlier publications about the age of the fossil. They also cover new ground, suggesting that Little Foot was an adult female and stood about 130 centimetres tall — just 10 centimetres shorter than the average woman in some modern-human populations. "Little Foot was quite big," says Crompton. The paper covering limbs and locomotion[3] reveals that Little Foot's legs are longer than her arms, similar to modern humans, making her the oldest hominin for which we can be sure of that feature, says Crompton. This means that Little Foot was better adapted to walking upright on the ground than were many other australopiths.

Little Foot's skull, bones and teeth are so unusual that Clarke and his team have categorized her as the distinct species[4] *Australopithecus prometheus*, a name first suggested in 1948 on the basis of a skull fragment found roughly 250 kilometres north of Johannesburg[6] and that remains controversial. They also suggest that *A. prometheus* is an ancestor of a group of hominins called *Paranthropus*[4], which co-existed with early *Homo* species for about one million years.

But Lee Berger, an archaeologist also at Wits University, disagrees with the decision to resurrect *A. prometheus*. In a paper scheduled to be published in the *American Journal of Physical Anthropology*, he argues that the name *A. prometheus* was never properly defined. If Little Foot constitutes a distinct species, Berger thinks, a new name is needed.

He is also disappointed by the lack of solid information in the papers on the age and locomotion — he would have liked to have seen detailed measurements of the fossil bones. "There's no data — there are almost no measurements of the fossils," he says. Berger hopes to provide those data in his own publications — although he is still at an early stage of his analysis of Little Foot.

Crompton responds that the locomotion paper is an overview that attempts to reconstruct how Little Foot moved by drawing on the more-solid data in the team's other papers. Gabriele Macho, an anthropologist at the University of Oxford, UK, agrees that the locomotion paper is light on solid data, but says the team acknowledges the gap. She looks forward to seeing more-detailed papers soon. "The positive thing is this skeleton is tremendously important," she says. "No question about it." ■

1. Bruxelles, L., Clarke, R. J., Mairee, R., Ortega, R. & Stratford, D. *J. Hum. Evol.* **70**, 36–48 (2014).
2. Bruxelles, L. *et al.* Preprint at bioRxiv https://doi.org/10.1101/482711 (2018).
3. Crompton, R. H. *et al.* Preprint at bioRxiv https://doi.org/10.1101/481556 (2018).
4. Clarke, R. J. & Kuman, K. Preprint at bioRxiv https://doi.org/10.1101/483495 (2018).
5. Heile, A. J., Pickering, T. R., Heaton, J. L. & Clarke, R. J. Preprint at bioRxiv https://doi.org/10.1101/486076 (2018).
6. Dart, R. A. *Am. J. Phys. Anthropol.* **6**, 259–284 (1948).

GENETICS

Machine learning hunts for cause of paralysing illness

Scientists hope that probing the immune system will identify the cause of a polio-like disease.

BY SARA REARDON

Infectious-disease researchers hunting for the cause of a mysterious illness that is paralysing children are combining machine learning with a new gene-sequencing technique to pin down the culprit.

The disease, called acute flaccid myelitis (AFM), causes limb weakness and paralysis that resembles the symptoms of polio. The US Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, has confirmed 134 cases of AFM in the United States so far this year. Many of those who develop the illness never recover.

Most of the evidence suggests that an enterovirus called EV-D68 is causing the illness[1], but researchers haven't been able to find the pathogen in the spinal fluid of children with the disease. Scientists are trying to identify the culprit by using a combination of host-response diagnostics — which look at how the immune system responds to pathogens — and machine-learning analysis. The approach could lead to better diagnostics and provide hints about new treatments.

Host-response diagnostic tests haven't been used in the clinic yet. But researchers are developing similar tests to help pinpoint other conditions that can be tricky to diagnose, including tuberculosis and bacterial meningitis.

"We've never really had a smoking gun."

This year's AFM outbreak started in October, and is the third in a series of outbreaks in the United States that have occurred every other year since 2014. Researchers have yet to find a definitive explanation for the pattern. It is also taking scientists an unusually long time to determine the cause of the illness, says William Weldon, a microbiologist at the CDC.

Blood samples taken from many of the people with AFM contain the virus. But many people who never developed AFM symptoms also have the virus in their blood.

"We've never really had a smoking gun," says Charles Chiu, an infectious-disease researcher at the University of California, San Francisco, who is leading the machine-learning project. He suspects that if EV-D68 causes AFM, it damages the spinal cord quickly and then drops to undetectable levels in the body.

Host-response diagnostics are useful when researchers don't know what they're looking for, says Purvesh Khatri, a computational systems immunologist at Stanford University in California. The composition of the immune system's defences differs depending on which pathogens are present in the body. So instead of looking for the agent itself, Khatri says, researchers could look at what the immune system is seeing.

Most attempts to identify mystery illnesses involve searching for a pathogen's DNA or RNA in areas of the body such as tissue or blood. But the host-response technique takes a blood sample and sequences all of the