NEW HUMAN SPECIES: *Homo naledi* raises questions about the origin and evolution of our genus. In this replica of the composite skull, white areas indicate missing bone.

EVOLUTION

MYSTERY HUMAN

An astonishing trove of fossils has scientists, and the media, in a tizzy over our origins

By Kate Wong

IN BRIEF

In 2013 cavers discovered a trove of enigmatic fossils deep inside an underground cave system known as Rising Star near Johannesburg, South Africa.

Over the course of two expeditions scientists recovered more than 1,550 specimens belonging to at least 15 individuals from the site.

Last September researchers unveiled the discovery to great fanfare, announcing that the bones represent a new species, *Homo naledi*, that calls into question long-standing ideas about the rise of *Homo*.

Critics have raised concerns about the recovery and analysis of the fossils.

Kate Wong is a senior editor at *Scientific American*.

IN THE BRAND-NEW FOSSIL VAULT at the University of the Witwatersrand, Johannesburg, in South Africa, shelf space is already running out. The glass-doored cabinets lining the room brim with bones of early human relatives found over the past 92 years in the many caves of the famed Cradle of Humankind region, just 40 kilometers northwest of here. The country's store of extinct humans has long ranked among the most extensive collections in the world. But recently its holdings doubled with the discovery of hundreds of specimens in a cave system known as Rising Star. According to paleoanthropologist Lee Berger and his colleagues, who unearthed and analyzed the remains, they represent a new species of human—*Homo naledi,* for "star" in the local Sotho language—that could overturn some deeply entrenched ideas about the origin and evolution of our genus, *Homo*.

HOLE IN THE GROUND: Fossils of *Homo naledi* were found in a cave in South Africa's Cradle of Humankind.

Berger is camera-ready in a brown leather blazer and set to give his spiel to the dozen or so journalists, including me, gathered around him in the vault in late 2015. He directs the visitors' attention to the six black carrying cases—originally made to hold assault rifles—arrayed on tables around the room. Each contains a dizzying assortment of fossils nestled in its foam-lined interior. In the cabinets along the back wall, more *H. naledi* bones fill dozens of clear plastic containers labeled "cranial fragments," "pelvis," "radius." Berger reaches into case number two, which holds the crown jewels of the Rising Star assemblage—the group of bones that defines the species—and lifts out an upper jaw and a lower jaw. He carefully holds them one atop the other and displays the matched pair with a practiced flourish so that everyone gets a good look. The crowd murmurs appreciatively, pens scribble, camera shutters click, flashes pop. And he glides on to the next specimen, fielding questions, posing for photographs and encouraging the visitors to snap selfies with the vault's celebrity charges.

Just a few decades ago the sum total of fossils belonging to our extinct human relatives, also called hominins, could fit in a desk drawer. Those destitute days are long gone. Scientists have since amassed more evidence of the evolutionary history of the human family than of many other animal groups, including our closest living relatives, the great apes. As a result, they now know, for example, that humanity's roots reach back at least seven million years and that for much of that time our ancestors shared the planet with other hominins.

Yet they still have much to learn. Some chapters of the human story are completely unknown from the fossil record; others have been drafted on the basis of evidence so scanty that they are little more than speculation. And so even though the fossil record of humans is vastly bigger than it once was, it is still imperfect enough that new discoveries often alter scientists' understanding of the details of humanity's past—sometimes significantly so.

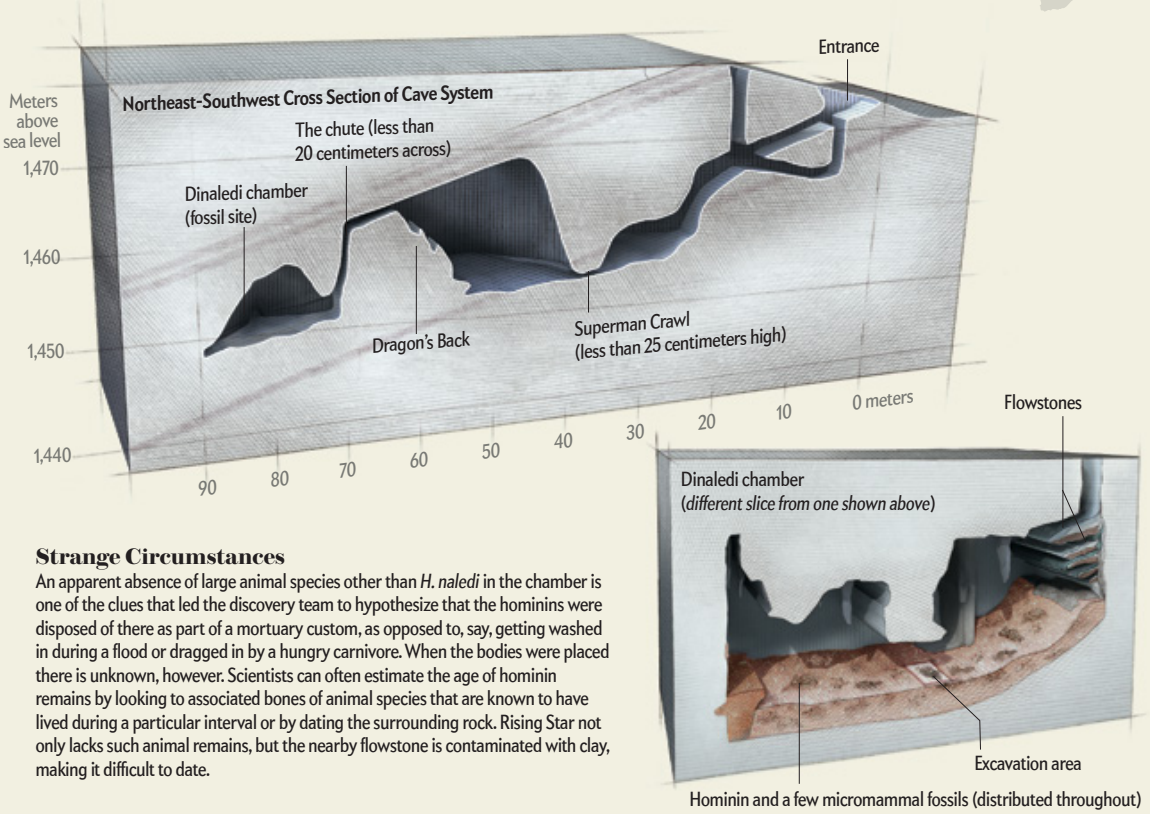
The Rising Star fossils are the latest to rock the paleoanthropology establishment. Berger and his team argue that *H. naledi* could illuminate the long-sought roots of *Homo* and revamp the human family tree. What is more, the researchers suggest, this creature, which had a brain the size of an orange, engaged in ritual behavior previously attributed exclusively to much brainier hominins—a finding that could upend the prevailing wisdom linking cognitive sophistication to large brain size.

Some critics have dismissed these claims outright. Others have greeted them with uncharacteristic reticence. One major stumbling point for many is that the age of the bones is unknown. They could be more than four million years old or less than 100,000 years old. The lack of a date is not the only concern weighing on outside observers, however. The way the fossils were unearthed, analyzed and revealed to the rest of the world has vexed some of the field's leading scholars, who charge that Berger and his colleagues rushed the job and prioritized publicity over

PRECEDING PAGES: ISTOCKPHOTO (*pashpins*); COURTESY OF JOHN HAWKS *University of Wisconsin–Madison* AND UNIVERSITY OF THE WITWATERSRAND (*all other photographs*)

Chamber of Bones

Cavers discovered the fossils of the new human species *Homo naledi* in an underground cave known as Rising Star, just outside Johannesburg, South Africa (*right*). The bones come from the so-called Dinaledi chamber, which sits 30 meters below the surface. To reach it, excavators had to undertake steep climbs and squeeze through tight passages (*below*). *H. naledi* may have taken similar pains to get there: researchers think it may have been intentionally disposing of its dead in the chamber (*inset*), and although geologists are still working to understand how the cave evolved over time, they have yet to identify other plausible routes into the chamber.



Strange Circumstances

An apparent absence of large animal species other than *H. naledi* in the chamber is one of the clues that led the discovery team to hypothesize that the hominins were disposed of there as part of a mortuary custom, as opposed to, say, getting washed in during a flood or dragged in by a hungry carnivore. When the bodies were placed there is unknown, however. Scientists can often estimate the age of hominin remains by looking to associated bones of animal species that are known to have lived during a particular interval or by dating the surrounding rock. Rising Star not only lacks such animal remains, but the nearby flowstone is contaminated with clay, making it difficult to date.

SOURCE: "GEOLOGICAL AND TAPHONOMIC CONTEXT FOR THE NEW HOMININ SPECIES *HOMO NALEDI* FROM THE DINALEDI CHAMBER, SOUTH AFRICA," BY PAUL H.G.M. DIRKS ET AL., IN *ELIFE*, ARTICLE NO. 09561; PUBLISHED ONLINE SEPTEMBER 10, 2015

science. In a field known for its fierce rivalries, heated debate over new finds is the norm. But there is more on the line in the row over the Rising Star remains than a few egos. How scientists respond to this discovery in the longer term could set a new course in the quest for human origins, changing not only the questions they ask but the ways in which they attempt to answer them.

CHAMBER OF SECRETS

IN A WAY, it was a set of grainy photographs shown to Berger on October 1, 2013, that sparked this spectacle. Berger had hired geologist Pedro Boshoff to search the Cradle for new hominin sites. Over the years miners and fossil hunters had combed the region many times over. But Berger had good reason to think there was more to find. Five years earlier his then nine-year-old son had stumbled across bones of a previously unknown member of the human family, *Australopithecus sediba,* right in the middle of the Cradle.

Now Boshoff and local cavers Rick Hunter and Steven Tucker had found what appeared to be human bones littering the floor of an extremely difficult-to-reach chamber 30 meters down in the Rising Star cave system, just a few kilometers from the spot where Berger and his son had found *A. sediba*. The explorers had not collected any of the material, but they had taken pictures. As soon as Berger saw them, he knew the bones were important. They had features that clearly differed from those of anatomically modern humans—*Homo sapiens*. And there were lots of them, enough to represent a skeleton.

Berger immediately began making plans to recover the remains. There was a problem, though. He was not going to be able to collect them himself. The route from the cave entrance to the chamber that held the bones contained passages far too narrow to accommodate Berger's broad frame or that of most of his scientist colleagues for that matter. Widening these passages would disrupt the integrity of the cave and possibly damage the bones—

Illustration by José Miguel Mayo

a nonstarter, as far as he was concerned. So he put out a call on Facebook for skinny scientists who had experience caving and excavating old remains and who could come to Johannesburg on short notice to mount an expedition in exchange for little more than a plane ticket and the promise of adventure.

Five weeks after Boshoff showed him the tantalizing photographs, Berger had selected his team of excavators—all women, coincidentally—to carry out the difficult, dangerous work of recovering the bones from the chamber, as well as a crew to support the team's efforts; he developed a protocol for collecting the material and documenting exactly where in the chamber each piece of bone came from; and he established a group of senior scientists to oversee the excavation via closed-circuit television and to identify, log and store the specimens as they came out. He also had a plan for how to publicize the endeavor—a full-bore media blitz, carried out in partnership with *National Geographic* and *NOVA,* that would include live tweets and daily blogs, radio interviews and video clips posted from the field, as well as a TV documentary that would air at a later date, after the remains were eventually published. On November 10, cameras rolling, the excavators crawled, climbed and wriggled their way into the pitch-dark chamber and began the recovery effort.

Marina Elliott was the first scientist to enter the chamber. "I didn't know what to expect, but I was excited," she recalls when I accompany her to the Rising Star site. It is high noon on a bright, hot austral summer's day, and outside the cave the wind carries the sound of cars whizzing past on the nearby freeway. But inside the cave it is dim and cool and hushed—the stillness of age. A shaft of light from a natural opening in the ground above bathes the craggy interior, giving it the air of a place of worship.

The serenity of this part of the cave belies the danger farther in, however. Elliott shines her flashlight down one of the corridors, illuminating a perforated curtain of limestone. Behind that wall lies the first of the squeeze points on the route into the fossil chamber, she explains—the Superman Crawl, a tunnel that the women had to negotiate belly to ground and one arm outstretched. The journey did not get easier from there. The jagged Dragon's Back loomed ahead, followed by a 12-meter-long, vertical chute less than 20 centimeters (eight inches) across that opened into the chamber of bones.

But their efforts were richly rewarded. There were bones everywhere—much more than the single skeleton Berger had expected to salvage. Over the next 21 days Elliott and her colleagues hauled out 1,200 specimens. A second, shorter expedition in March 2014 yielded several hundred more. In total, the team recovered more than 1,550 bones and bone fragments of at least 15 individuals—including infants, tweens, young adults and old-timers—from an area the size of a card table. All told it is one of the largest single assemblages of hominin fossils ever found. And the team only scratched the surface. More bones, possibly thousands more, remain in the chamber.

A STAR IS BORN

WITH SAFE AFTER SAFE stuffed with hominin fossils, Berger and his colleagues now faced the daunting prospect of assessing them. Even before the researchers began their formal assessment, while the bones were still coming out of the ground, the find had an air of mystery about it. For one thing, the bones appeared to have a weird combination of primitive and modern traits. For another, no animal remains apart from those of a few small birds and rodents had turned up in the chamber along with the hominin bones. Larger animals such as monkeys, antelopes and hyenas, almost always accompany hominin fossils, particularly those found in underground caves. The absence of such species at Rising Star demanded explanation.

Berger recruited an army of 35 early-career researchers to help describe the fossils over the course of a monthlong workshop in Johannesburg in May 2014. For most of these people—many still working on their Ph.D.s—it was a rare opportunity to work on new fossils, as opposed to studying material that had already been characterized by other, more seasoned scientists. They worked in groups organized by body part: skull, hand, teeth, spine, hip, leg, foot, and so forth.

When they pooled their findings, a startling picture emerged of a tall, slender hominin with upper limbs built for climbing and using tools, lower limbs built for upright striding and a tee-

HEAD TO TOE: Vast Rising Star fossil assemblage includes rare foot bones (*far left*) and multiple leg bones (*near left*). Though fragmentary, the fossils are beautifully preserved and can in some instances be attributed to the same individual, as is the case for the lower jaw and skull fragments above.

ny brain. It is "a really, really strange creature," Berger says.

On a Friday afternoon in December, senior team member John Hawks of the University of Wisconsin–Madison takes me back to the vault to point out some of the salient aspects of the Rising Star remains. The rest of his colleagues are still outside enjoying beer and barbecue at the department holiday party, but Hawks is in his element here among the bones. He bustles around the room, setting the fossil cases out on the tables and selecting replicas of other hominin specimens from the vault's vast collection for comparison.

The skull alone is a mishmash of traits associated with various hominin species. It would have held a brain measuring just 450 to 550 cubic centimeters—as small as that of primitive *Australopithecus afarensis,* best known from the 3.2-million-year-old Lucy skeleton, found in 1974 in Ethiopia. Yet the shape of the skull evokes the more humanlike *Homo erectus.* The teeth resemble those of *Homo habilis,* one of the most primitive members of our genus, in the way they increase in size from the front of the tooth row to the back. But overall the teeth are small, and the molars have simple crowns with fewer, lower cusps—traits associated with later *Homo.*

The bones below the head echo the mix-and-match theme. The upper limb pairs a shoulder and fingers adapted to climbing with a wrist and palm built for manipulating stone tools—an activity that was not thought to become important to hominins until after they had abandoned life in the trees and evolved large, inventive brains. And the lower limb marries a Lucy-like hip joint to a foot that is virtually indistinguishable from our own. Researchers have been operating under the assumption that the signature features of *Homo*—such as a toolmaking hand, big brain and small teeth—evolved in concert. "*Sediba* and *naledi* show that things we thought we evolved together did not," Hawks asserts.

This unprecedented combination of primitive and modern features is not the only distinctive thing about *H. naledi*. The fossils also have traits never before seen in a member of the human family. Hawks plucks one of the finger bones out of its foam cutout. It is the first metacarpal, the bone in the palm that sits below the thumb, and when he displays it next to the same bone from *H. sapiens,* the difference is stark. The shaft of its first metacarpal is smooth, thick and broad for its entire length. *H. naledi*'s, in contrast, is narrow at the base and broad at the top, with a sharp crest running along its shaft and thin wings of bone on the sides. The femur bears unique traits, too, as do other elements.

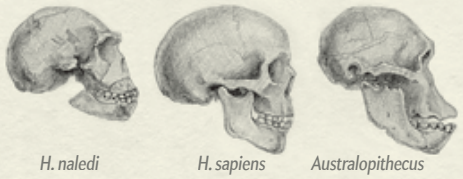
To Berger and his colleagues, the novel combination of australopithecine and *Homo* characteristics, along with the presence of unique traits, easily justified assigning the Rising Star fossils to a new hominin species. Although the researchers have yet to establish the age of the fossils, in their paper announcing the find, published last September in the online open-access journal eLife, they proposed that, given its primitive features compared with early *Homo* species such as *H. habilis* and *H. erectus, H. naledi* might be older than two million years and stem from the base of the genus *Homo*. If so, the discovery would be a major coup: the origin of *Homo* is arguably the biggest unsolved mystery in all of human evolution because fossils transitional between the australopithecines, with their many apelike traits, and later *Homo,* with its modern body plan, are exceedingly rare and mostly scraps. Scientists have been eager to elucidate which hominin species founded the *Homo* branch of the hominin family tree and how the traits in the modern human body plan evolved with new discoveries.

Berger's team did not stop at saying the find could bear on the origin of *Homo,* however. It argued that the unexpected mix of traits evident in *H. naledi* implies that isolated fragments cannot be used to understand the evolutionary relationships of fossil humans, because the part cannot predict the whole—fighting words to those researchers who have interpreted isolated bones as the earliest evidence of the *Homo* lineage.

Perhaps even more provocative than the team's ideas about what *H. naledi* means for understanding hominin relationships

A Novel Mix

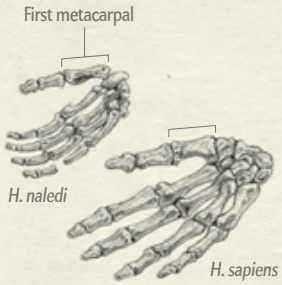
The excavations at Rising Star have yielded more than 1,550 fossil specimens of *Homo naledi* belonging to at least 15 individuals ranging from infants to oldsters. Nearly every bone in the body is represented in the collection, many of them more than once. From these remains scientists have reconstructed a creature with a startling combination of traits associated with the primitive australopithecines and traits seen in various species in our genus, *Homo*, as well as some traits not known from any other hominin species. Examples of these features are highlighted in the diagram below.



Skull of *H. naledi* housed a brain as small as 450 cubic centimeters—a size that is typical for australopithecines but significantly smaller than the brains of *H. sapiens* and most other members of *Homo*.

Teeth are primitive in the way they increase in size from front to back. Overall they are small, and the molars have comparatively simple cusps—both traits of later *Homo* species.

Shoulder socket faces up like an ape's or australopithecine's rather than out to the side like ours does. This upward orientation is an adaptation to climbing trees.



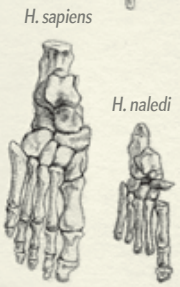
Femur has a small head and long neck compared with the large head and small neck seen in the *Homo sapiens* femur. These features suggest that *H. naledi*'s hip worked like an australopithecine's.

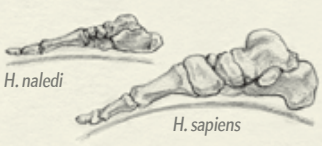
Hand has strongly curved fingers, suggesting that *H. naledi* climbed in trees. Yet the wrist and palm look modern and appear to be adapted to manipulating tools. For its part *H. naledi*'s first metacarpal, the bone in the palm below the lowermost thumb bone, looks neither *Homo*-like nor *Australopithecus*-like and is utterly unique.

A New Twig in Our Tree

The discovery team argues that *H. naledi*'s particular mix of characteristics suggests that the species originated close to the origin of *Homo*—a coveted spot in the family tree. But *H. naledi* preserves parts of the anatomy that are not known for other early *Homo* species, complicating efforts to understand how these extinct hominins are related to one another—and to us.

Foot is remarkably like our own, apart from the slightly curved toes and somewhat lower arch, and thus well adapted to upright striding. But the combination of this modern foot and the primitive hip means *H. naledi* would have walked differently from us.





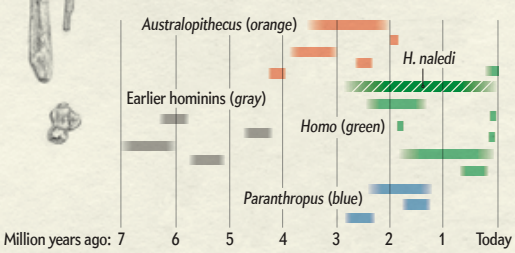


Illustration by Portia Sloan Rollings, Graphic by Jen Christiansen

is how it interpreted *H. naledi*'s behavior. In their attempts to figure out how the hominins ended up in the chamber, the researchers considered a number of mechanisms known to account for hominin accumulations at other sites, including the possibility that their bones had washed into the cave system during a flood or that large carnivores had dragged them there to eat. Yet the available evidence did not match any of those explanations. Floodwaters, for instance, would have surely carried the remains of other animals into the chamber, too. And carnivores would have left behind telltale tooth marks on the bones. All things considered, the team concluded, the likeliest explanation was that *H. naledi* had intentionally deposited the bodies in the chamber.

The hominins would have had to go to considerable lengths to do so. Although the team geologists do not yet know exactly how the Rising Star cave system formed and changed over time, they have found only one entrance to the bone chamber—the one the excavators squeezed through to recover the fossils. If that was indeed the only entrance, then whoever disposed of the dead would have had to, at minimum, scale the 20-meter spine of the Dragon's Back to reach the opening of the chute that opens into the chamber. From there they could have either crawled down the chute with the bodies or just dumped them in and let them slide into the chamber below. And if the route into the chamber was always pitch-dark, as the team thinks it was, then the hominins may have required an artificial light source to find their way in. The suggestion was that tiny-brained *H. naledi* not only had a mortuary ritual but mastery of fire.

Ensconced in a leather club chair in the sitting area of his office, coffee mug in hand, Berger launches into a discussion of what the Rising Star find means for human evolution. It's 7:30 in the morning, but the blinds are drawn, and the lights are low. Between the animal hide rugs decorating the floor and the jazz warbling from a vintage-style turntable, the room feels more like a gentleman's hunting lodge than a work space. "There is no age at which [the find] is not disruptive," he exults. If it is old, then critical physical and behavioral traits may have emerged at the root of our genus or earlier, rather than in later *Homo.* Really old *H. naledi* could even oust the australopithecines from the line leading to us, according to Berger. If, on the other hand, the fossils are young, researchers are going to have to reconsider which species left behind the cultural remains at key archaeological sites across Africa.

It may be *H. naledi* originated millions of years ago and managed to persist across the ages unchanged, like a coelacanth, overlapping with other *Homo* species, including *H. sapiens,* for a time. Perhaps it invented some of the cultural traditions archaeologists have traditionally assumed originated with our kind, Berger says. Possibly *H. naledi* interbred with our ancestors and contributed DNA to the modern human gene pool, like Neandertals and Denisovans did.

CASTING ASPERSIONS

WHEN THE TEAM published its papers announcing the discovery in eLife last September, the world went wild for *H. naledi*. Seemingly every media outlet on the planet covered the find. Even the *Onion* joined the bandwagon, running a doctored image of a lachrymal Berger with a story entitled "Tearful Anthropologists Discover Dead Ancestor of Humans 100,000 Years Too Late." Yet underneath that tidal wave of public enthusiasm runs a current of discontent among some of paleoanthropology's elite. No one disputes that the find is important—a cave full of human fossils is extraordinary—but the team's approach to recovering, describing and interpreting the bones has raised eyebrows.

Berger is no stranger to side eye from his academic peers. Telegenic and silver-tongued, he hooked up with *National Geographic* early in his career. The relationship brought research funding, bylines and television appearances. Yet he had found few fossils, and his scientific papers and popular writings met with accusations of sloppy scholarship and grandstanding from some of paleoanthropology's most respected figures, including Tim White of the University of California, Berkeley, and Bernard Wood of George Washington University.

Berger's discovery of *A. sediba* in 2008 raised his scientific profile. Even his harshest critics conceded that the find, which included two largely complete skeletons dated to 1.98 million years ago, was spectacular. But many did not agree with his interpretation of it. Berger had long contended that South Africa was being overlooked in favor of East Africa in the search for *Homo*'s origin. *A. sediba,* with its mosaic of australopithecine and *Homo* traits, seemed to offer a means of potentially rooting *Homo* in South Africa. The problem was that the oldest fossils attributed to *Homo* were East African specimens older than *A. sediba.* Berger argued that fossil fragments like the ones from East Africa that were being held up as the earliest *Homo* could no longer be assigned to one taxon or another because his skeletons, with their surprising combination of traits, showed the whole was not inferable from the part. His peers largely rejected that claim.

With *H. naledi,* Berger doubled down on the public outreach and on those controversial ideas about *Homo*'s origin and fragmentary fossils. It did not take critics long to loose their arrows. White told his university's alumni association magazine, *California,* that the Rising Star fossils looked like primitive *H. erectus,* not a new species. White is best known for his discoveries of hominin fossils in Ethiopia, including those of 2.4-million-year-old *Australopithecus garhi,* which he and Berhane Asfaw of the Rift Valley Research Service and their colleagues said were from the right time and place to be ancestral to *Homo.* He further accused the Rising Star team of damaging fossils during excavation and rushing its findings to publication. Later, in a scathing blog post for the *Guardian,* White warned of the dangers of mixing science and showmanship. "We are witnessing portions of science collapsing into the entertainment industry," he wrote.

White is not the only one with concerns. Carol Ward of the University of Missouri cautions that although the quantity of fossils is stunning, their significance remains unknown. She emphasizes the importance of determining the age of the bones: "When we know how old they are, then we can tell you what they mean for human evolution but not until then."

Ward also has misgivings about the paper describing the fossils, noting that it did not include sufficient data about how they compare with other relevant fossils for outside scientists to be able to evaluate many of the team's claims. Nor did the paper contain a phylogenetic analysis—basically a study in which a computer program compares traits across a group of organisms and thereby reconstructs the members' evolutionary relationships—which could reveal where *H. naledi* fits in the human family tree. "There seems to be a great desire [on the part of the authors] for it to be related to the origins of *Homo,*" she observes, but in the absence of a detailed phylogeny or a date, no one can know if it is.

Many researchers stand by the thinking that, based on present evidence, *Homo* debuted in East Africa. Last March, months before the details of *H. naledi* were released, Brian Villmoare of the University of Nevada, Las Vegas, Kaye Reed of Arizona State University and their colleagues announced their discovery of a 2.8-million-year-old piece of lower jaw from the site of Ledi-Geraru in northeastern Ethiopia that they say is the earliest known representative of our genus. The jaw has clear hallmarks of *Homo,* they observe, as well as traits transitional between *Australopithecus* and *Homo*. Without a date, the *H. naledi* fossils cannot unseat the Ledi-Geraru jaw as the oldest evidence of our lineage, in Reed's view, nor does she accept the argument made by Berger, Hawks and their colleagues, that isolated fragments of anatomy cannot be reliably assigned to one taxonomic group or another. "I have a good date at 2.8, and there are features of *Homo,*" she maintains.

Part of the reason paleoanthropologists disagree on which fossils herald the dawn of *Homo* is that they are divided over what constitutes *Homo* in the first place. *H. naledi* "highlights an ongoing debate about how to define *Homo,* both for things we have pieces of and things we have more of," comments Susan Antón of New York University, an expert on early members of our genus. Sorting *Homo* from *Australopithecus* is "a very messy thing for everyone right now, and different people have different philosophies about how to make that distinction." She and her collaborators have been defining it on the basis of traits found in the cranium, jaws and teeth. Others have argued that the distinction between the two has to be based on the bones below the head—the postcrania, as they are termed—because they reflect the major adaptive changes hominins underwent as they transitioned from wooded environments to open ones. But those postcranial bones are largely unknown for early *Homo* species. The Rising Star fossils are "an embarrassment of riches," Antón remarks. But the mosaic of traits gives mixed signals, and Berger's team did not explicitly state how it defines *Homo* and why. "We have a lot more talking to do," she says of the field.

Yet even if the Rising Star remains do constitute a new *Homo* species and even if they turn out to be more than two million years old, those facts alone may not be enough to sway the skeptics toward the notion that *H. naledi* was on or near the line leading to us. George Washington University's Wood suspects that the bones represent a relic population that might have evolved its odd traits in relative isolation. "South Africa is a cul-de-sac at the bottom of the African continent," he says. "My guess is gene exchange in this cul-de-sac was probably not as common as it was in East Africa, where you have a lot more potential for homogenization, with genes coming in from southern and central Africa." Wood points to another weird species of *Homo*—the small-brained, small-bodied *Homo floresiensis* that persisted on the island of Flores in Indonesia long after *H. sapiens* originated in Africa—as another example of such a relic population.

The suggestion that small-brained *H. naledi* was ritually disposing of its dead has likewise met with resistance. "It would be quite radical," says archaeologist Alison Brooks of George Washington University. The practice is widely thought to be exclusive to the much larger-brained anatomically modern humans and possibly Neandertals and only became commonplace after 100,000 years ago. "I don't want to rule it out entirely that [the Rising Star researchers] are right," Brooks adds, "but I just think it is so far out there that they really need a higher standard of proof."

GETTING A GRIP: Hand of *H. naledi* is the most complete one known for an extinct human species.

In fact, some of the discovery team members themselves struggled with the idea that *H. naledi* was deliberately disposing of its dead in that underground chamber, if only for logistical reasons. "It's hard to get in there with my backpack, never mind dragging a body," Elliott reflects. "But we spent two years trying to find an alternative and couldn't."

If *H. naledi* did in fact transport the dead to the chamber, its behavior need not necessarily reflect cognitive sophistication, however. Travis Pickering of the University of Wisconsin–Madison, who has worked in the Cradle of Humankind for the past 20 years, agrees that intentional disposal of the remains by other hominins is the most sensible explanation for how the bones got into the remote chamber. But "whether that means *Homo naledi* was a rather culturally advanced species with well-developed mortuary practices or simply an atavistic one that had the sense not to cohabit with rotting corpses is currently unanswerable," he comments.

EYE ON THE PRIZE

BERGER DISMISSES THE DETRACTORS, noting that they have made their comments strictly in the popular press and on social media, not in the rigorous forum of a scientific journal. "Their evidence stops at their mouths," he says. Staunchly defending the care with which the team excavated the fossils, he explained in a public post on Facebook that the damage on the bones was already there when Rising Star team members first arrived on the scene. Berger presumes it resulted from unknown amateur cavers who had explored the chamber before them and stepped on the bones. The excavators were able to work quickly, he says, because "we didn't have a lot of problems other teams have." At other sites, fossils are

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typically encased in rock. Excavation and cleaning of such fossils are typically extremely laborious and time-consuming. But at Rising Star the fossils were simply lying in damp earth that brushed away easily. And unlike other teams, which are small and conduct their research in distant locales six to eight weeks a year, Berger's is large and based in Johannesburg, so it can work at the site or in the vault any time. If you look at the Rising Star work in terms of person-hours logged in the time between discovery and publication, "it's as much as anyone else has done," he insists.

As for White's suggestion that the fossils belong to primitive *H. erectus,* not a new species, "he disagrees with everything except the ones he basically has named," Berger quips. Assigning the *naledi* remains to *H. erectus* would mean that *erectus* had more variation than is seen in our own species, which is improbable, in his view. More to the point, *H. naledi* has unique traits not seen in any other hominin. "If we're going to be evolutionary biologists, the argument stops there," Berger declares. "Frankly I'm surprised [people] aren't arguing that it's a new genus," rather than merely a new species.

Asked about dating the Rising Star fossils, Berger says the geologists are working on it and will get the timing down eventually. But he maintains that the date will not change their understanding of how *H. naledi* is related to other members of the human family. Although *H. naledi* has some key traits of *Homo,* the overall package is in some ways more primitive than that of *H. habilis* and, for that matter, that of the Ledi-Geraru jaw that currently holds the title of oldest *Homo* fossil. No matter what age the Rising Star fossils turn out to be, they imply that *H. naledi*'s branch of the family tree sprouted before these other branches did. If the fossils are young, then they represent a late population of this species.

Why, then, didn't the team include a phylogeny in the paper announcing the fossils as a new species? To figure out how organisms are related to one another, evolutionary biologists use a method called cladistics that sorts taxa into groups based on novel characteristics they share with their last common ancestor but not earlier ones. The catch is, the method works best when the characteristics are observable in all the organisms in question.

Where fossils are concerned, meeting that requirement is easier said than done because they vary widely in the traits they preserve. In paleoanthropology, researchers have tended to base their cladistic analyses on traits found in skulls and teeth; skulls because they vary widely in form in hominins and thus historically were thought to be particularly useful for defining species and teeth because they are the most common elements in the hominin fossil record. Bones from the rest of the skeleton are not always found in association with skulls or teeth, so it can be difficult to assign them to a species that is defined by cranial or dental remains. Moreover, a skeletal element that is known in one species is often missing in another.

Indeed, some of *H. naledi*'s key elements—including its nearly complete sets of hand and foot bones—are only partly represented in the fossil record of other *Homo* species, such as *H. erectus* and *H. habilis,* if they are even represented at all. Lacking corresponding parts with which to compare them, the researchers could not conduct a cladistic analysis of *H. naledi* that factored in its many postcranial traits of interest. With that course of comparison closed off to them, the researchers ran an analysis based on skull and dental traits. But some of the test results did not make logical sense, suggesting that *H. naledi,* with its many primitive traits, is more closely related to *H. sapiens* than to the much older *H. erectus*. To Berger, that finding underscores that trees based on data from one anatomical region, such as the head or teeth, are unreliable.

Berger remains certain that *H. naledi* will shake up scientists' understanding of human evolution one way or another. But he is not asking his peers to take his word for it. In a departure from the usual way of doing things in paleoanthropology, which has a reputation for secrecy where access to fossils is concerned, he instituted an explicit policy for the Rising Star remains that makes them available to any researcher who applies to see them. And on the day they published the eLife papers, the researchers released free three-dimensional scans of critical bones on MorphoSource, a digital repository for anatomical data, allowing visitors to print their own 3-D replicas of the specimens. The data resolution is not yet high enough for the purposes of carrying out original research, but "it's good enough to check what we're saying," Berger says.

"It's such an overwhelming positive that people are getting access; the complaints are just noise," observes David Strait of Washington University in St. Louis. He notes that in 2000, White wrote a prominent editorial in which he asserted that, given the intense public interest in human origins, paleoanthropologists have a special duty to get things right. "That's completely wrong," Strait asserts. "Of course, we should try to do things well, but science should operate by falsifying possibilities. We narrow down the possible truths to get a better idea of what happened in the past, and there is always the possibility for new data to emerge that change everyone's thinking." By making the fossils available to other researchers, Strait says, Berger has given those scientists who disagree with him an avenue to test their ideas against his: "The field moves forward only if people can study the stuff."

In the meantime, with or without the opposition's approval, work will continue apace at Rising Star. The geologists are busy reconstructing the history of the cave, the excavators are recovering more fossils from the chamber, the molecular biologists will attempt to extract DNA from the bones. And the fossil hunters are seeking new leads. "[*Homo naledi*] should launch the greatest age of exploration there ever was," Berger declares with characteristic zeal. If it doesn't, maybe the team's next find will: he reveals that his explorers have already made additional progress on that front. Pressed for more detail, Berger demurs, other than to say with a sly grin that they have located "more than one" new site that has set his heart to racing like Rising Star did when he first saw those grainy photographs. The show will go on. SA

MORE TO EXPLORE

***Homo naledi*, a New Species of the Genus *Homo* from the Dinaledi Chamber, South Africa.** Lee R. Berger et al. in eLife, Article No. 09560. Published online September 10, 2015.

Geological and Taphonomic Context for the New Hominin Species *Homo naledi* from the Dinaledi Chamber, South Africa. Paul H.G.M. Dirks et al. in eLife, Article No. 09561. Published online September 10, 2015.

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First of Our Kind. Kate Wong; April 2012.

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