

High Life of a Tibetan Rhino

Discovery of a fossil skull points to the origins of Ice Age megafauna.

BY XIAOMING WANG

It's an August afternoon in the Zanda Basin in southwestern Tibet, in the foothills of the Himalayas. I am wandering aimlessly in a patch of badlands, slightly lightheaded owing to the more than 14,000-foot elevation, scanning the ground for any signs of fossils, or for that matter, anything that might distract me from the monotony of a day of fruitless search. It is late into our field season, and besides a tooth fragment or two, I have little to show for a day's work, something all vertebrate paleontologists learn to endure. On impulse I head farther west along a layer of rusty yellow sandstone, and there I see a piece of reddish-brown bone sticking out of the dirt. A few quick sweeps of my brush reveal a ring-shaped bone. Upon digging it out, I recognize it is an atlas—the neck vertebra that con-

nects with a skull—possibly from a rhinoceros. Not a bad find, but not something to get overly excited about. After I remove it, there doesn't appear to be anything left in the rock. But for good measure, I take one last whack at the sandstone with my geological hammer—just to see if I have missed something. A complete rhino cheek tooth tumbles out from the tip of my hammer.

That was in 2007, years after I first learned about the Zanda Basin. In the late 1990s, when my team had been collecting fossils in the northern reaches of the Tibetan Plateau, William R. “Will” Downs III sent me his translation of a paper on the basin's stratigraphy by a group of geologists from the Chinese Academy of Sciences. They had reported finding a right maxilla (upper jawbone) of an extinct giraffe,

The site of an ancient lake during the Pliocene epoch (between 5.3 million and 2.6 million years ago), Tibet's Zanda Basin now presents a vista of eroded sedimentary rocks.



GOOGLE EARTH

Landsat image of the Zanda Basin, an area of about 1,000 square miles, reveals river channels that have exposed the fossil beds.

Palaeotragus, roughly dating from between 5 million and 2 million years ago. A self-taught vertebrate paleontologist, Downs had long experience working in the Siwalik

Hills of Pakistan, on the southern flank of the Himalayas. He also contributed immeasurably to the progress of Chinese paleontology by translating many such scholarly publications into English—a skill he learned in Hong Kong and by participating in many field expeditions in various parts of China. With that single fossil as a clue, along with colleagues at the Natural History Museum of Los Angeles County I submitted a grant proposal to the National Geographic Society for an expedition. As fate would have it, Downs never did set foot in Zanda: he died of throat cancer in 2002, before we managed to raise enough funding.

I finally laid eyes on the Zanda Basin in 2006. Located in the southwestern corner of the Tibetan Plateau, it is a *graben*, an elongated block of terrain that, because of faults on either side, has sunk down relative to its surrounding mountains, here the Ayilariju to the northeast and the Himalayas to the south and west. During the Pliocene epoch (between about 5.3 million and 2.6 million years ago), the basin contained a lake, whose accumulated sediments are now layers of fossil-bearing rock. Those rocks have been exposed through erosion, in part by the cutting action of the Langqên Zangbo (Sutlej) River.

Having driven west from Lhasa, I stood at the edge of the Ayilariju Range overlooking the entire basin below. On the far side I could see distant peaks of the Himalayas. I was awestruck by the perfectly horizontal layers of rock, intricately shaped by down-carving streams over the eons. I was reminded of the Grand Canyon.

In my life as a vertebrate paleontologist, I had seen my share of badlands, but this was by far the most stunning. Tourist brochures commonly refer to the landscape as the “earth forest”, in a

Discovery of the skull and jawbones of an early woolly rhinoceros species high on the Tibetan Plateau suggests that the region—a frigid zone at the time the animal lived—may have been the nursery of the woolly rhino family tree. Woolly rhinos are better known from deposits in northern Eurasia that date from later, Ice Age times (2.6 million to 12,000 years ago). The Ice Age rhinos probably descended from the Tibetan species.



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The ruins of a late-tenth-century Buddhist monastery loom over Piyang, in the Zanda Basin. Riddling the underlying rock are natural and human-made caves that were used in the past for habitation and ritual.

nod to the better-known “stone forest,” the karstic terrain in the vicinity of Guilin, in southern China.

Among the sights to see is the town of Zanda, formerly known as Tholing, where in the tenth century a Tibetan king established one of the seats of the ancient Guge Kingdom. The Tibetans have a talent for building structures on dizzying cliffs, safe from the threat of foreign invaders. True to form, the ruins of the ancient capital sit on top of a hill. Ancient ruins and religious artifacts also dot the modern town of Zanda, seven miles to the east.

Although the Pliocene rocks were fantastic to look at, they did not prove eager to give up their fossil treasures. Their steep exposures did not help either—they were often too hard to climb, and in any case the thin air at that high altitude, between 12,500 and 14,800 feet, made hiking extra difficult. We did not find many fossils in 2006. Still, we knew we would be back for more.

ON THAT AUGUST DAY IN 2007, I realized that I had found something special. A few quick brushstrokes re-

vealed the complete left and right rows of upper cheek teeth of a rhino, with a strong possibility that the whole skull, maybe even with the lower jawbones, was still buried below. I knew I had to stop digging. Although I was leading the expedition, when it comes to excavating fossils Gary Takeuchi, our assistant collections manager at the Natural History Museum, is the real pro. I took down the GPS reading of the location, a standard procedure when we find new fossil sites, and snapped a few photographs. Working to my advantage, the day was cloudy: on clear days the harsh Tibetan sunshine tends to create too much of a contrast with deep shadows, obscuring surface details in a rock formation. I then called it a day, anticipating a return the following morning.

Unfortunately, the next morning it rained. We had no choice but to stay in town, so we spent the rest of the day assisting Li Qiang, one of our collaborators from the Chinese Academy of Sciences, who was beginning to amass a nice collection of fossils from small mammals. The task involved washing dirt through progressively

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finer meshes to retrieve isolated teeth, which are often preserved in suitable sediments. These tiny fossils, often visible only under a microscope, provide valuable information about the age of the rocks and the associated fauna, information otherwise missed by collecting only large bones.

We were also short-handed in those last few days of our field season because one of our Tibetan drivers had come down with acute tuberculosis, and we had to dispatch two of our team members to take him to the district hospital in Ali, also known as Gar. As if we did not have enough in the way of impediments, we discovered that we could not properly excavate the rhino skull because we had not anticipated needing powdered plaster of Paris, standard material for hardening the jackets used to protect large fragile bones. We debated whether or not we should leave the specimen in the field until the following year, when we would be properly equipped and have sufficient



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Gary Takeuchi, an assistant collections manager at the Natural History Museum of Los Angeles County, excavates the rhino skull discovered by the author. Because the skull was in an upside-down position, first to be exposed were the upper cheek teeth, shown here. Further digging into the hill yielded the lower jawbones, which had been disarticulated from the skull.

time to do a proper job.

But fate intervened. While our two team members were in Ali, they somehow managed to beg the hospital doctors there for medical plaster, normally reserved for emergency treatment of injuries, particularly for making casts for broken bones. The good doctors agreed and spared two bags for us.

BY THE FOURTH day after my initial discovery, the weather was finally cooperating, my team was at full strength, and we had plaster. We drove uphill to my rhino site.

Takeuchi led the team of excavators, which also included Li, Jack Tseng, Liu Juan (she and Tseng had been on our expeditions for three years and would soon be married), and Yang Wang (a geochemist from Florida State University). They labored for four days, improvising with whatever local materials they could scrounge to reinforce the jacket, including used chopsticks. While carrying the 300-plus-pound jacket over some gentle hills for the 500-yard trip to our car we were forced to take a rest every twenty steps, giving us a taste of what alpine mountaineers must experience at higher elevations. Takeuchi's experience paid off—the jacket was strong enough to withstand a three-day bumpy drive back to Lhasa, plus another week's drive back to Beijing.

Once safely deposited in the lab in the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing, the rhino skull and jawbones went through the usual tedious preparation to reveal their full glory of anatomical details, a process that took months. My colleague Deng Tao, a fossil rhino specialist, recognized that this was an ancestral woolly rhino, a spe-

cially new to science. We named it *Coelodonta thibetana*. Furthermore, our analysis indicated that our specimen belonged to the earliest and most primitive species yet known in the woolly rhino lineage.

Woolly rhinos became widespread in northern Asia and Europe during the Pleistocene epoch, or Ice Age, which started about 2.6 million years ago and ended about 12,000 years ago. We are fortunate because Euro-

pean Ice Age cave art vividly depicts their long woolly hairs, strong evidence that they lived in cold climates. Even more remarkable is the preservation in Siberian permafrost of their long hairs and their horns. My colleague Mikael Fortelius from the University of Helsinki, who joined us in our Tibetan rhino research, has long noticed that the horns often show two wear facets along their front edge that form a small angle, suggesting that a



JULIE SELAN

Artist's rendering of the Tibetan woolly rhino shows how it may have used its anterior horn as a snow and ice scraper to reach tundra vegetation that grew on the high plateau.



HEINRICH WENDEL © THE WENDEL COLLECTION, NEANDERTHAL MUSEUM

Rouffignac Cave in southwestern France boasts ten drawings of woolly rhinos; they date from late Ice Age times, about 13,000 years ago. Though marred by graffiti, this one clearly suggests the animal's shaggy coat and long, curved nasal horn.



TOP, DENG TAO; MIDDLE, SHEN WENLONG; BOTTOM, XIAOMING WANG

rhino would tilt and turn its head first left and then right while using its horn to scrape away at the ground. This could have been a means to scrape away snow and ice to reach the vegetation buried beneath. This may indicate alpine tundra vegetation close to the ground was the only food source in the harsh winter months.

We knew that during the Pliocene, Zanda Basin was already very high in elevation, equal to or even somewhat higher than its present-day elevation. Although worldwide climate during the Pliocene was slightly warmer than it is today, the sheer height of the basin resulted in a cold climate somewhat comparable to the present-day Arctic region. In fact, the Arctic during the Pliocene was many degrees warmer than it is today, making the Tibetan Plateau effectively the real “polar region” in the Northern Hemisphere at that time. Indeed, even today Tibet is known as the “third pole” in popular literature.

The discovery of an early progenitor woolly rhino living in cold Tibet about 5 million to 3 million years ago strongly suggests that ancestral woolly rhinos first honed their survival skills—and their horns—in the high plateau. Subsequently, when Pleistocene conditions in Arctic areas

Fossil of the Tibetan rhino skull and jaws, top, is shown in a three-quarters view. Middle: Side-view reconstruction drawing of the fossil is set in the animal's presumed profile. Rhino horns, made of keratin, lack a bony core that might fossilize, but horns from late Ice Age woolly rhinos have been discovered preserved in ice. Bottom: The anterior horn typically shows a pattern of wear consistent with being tilted and turned from side to side in a scraping motion. Red lines show reconstruction of the growth line along the length of a specimen horn and the missing portion. As much as two inches of the front of the horn was worn down.



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On their first trip to the Zanda Basin, in 2007, the author's team erected a simple memorial of Tibetan prayer flags in honor of Will Downs and spread some of his ashes. A vertebrate paleontologist, Downs had sparked the expedition with his translation of a Chinese technical paper, but had died before it could be mounted. Carried by the Langqên Zangbo (Sutlej) River, whose waters cut through the Himalayas, his ashes would ultimately follow the course of the great Indus River.

became suitable, the woolly rhinos were able to spread into that region. They were “preadapted” for life in the bitter cold of winter snows.

FROM THIS REASONING our “out-of-Tibet hypothesis” was born. The Pleistocene was the heyday of so-called megafauna, mammals weighing 100 pounds or more, many larger than their modern relatives. They included the extinct woolly rhino, giant sloths, and saber-toothed cats. We envision ancestral megafauna using high-altitude Tibet, with its cold habitat and thin air, as a “training ground” where they evolved anatomies and behaviors that later served them well in an Ice Age climate farther north. A burning question is whether, besides the woolly rhinos, Tibet could have also been a cradle for other such species.

We knew that a suite of large mammals roamed the Ice Age tundra of northern Eurasia and North America, including the iconic woolly mammoth. We also knew that some members of the megafauna, well adapted to the Arctic environment, managed to cross the frozen terrain of Beringia, a land bridge that connected Siberia and Alaska. That land bridge formed repeatedly, at the height of the continental glaciations, because the sea level dropped when water was locked into ice. The ancestors

of American megaherbivores, such as the musk ox, bison, and bighorn sheep, reached the New World from Asia by that route. Tantalizingly, living close relatives of the bighorns and bison are also found in and around the Tibetan Plateau. In fact, DNA evidence suggests that the iconic Tibetan yak and the bison are sister species.

In 2010, to the delight of our entire team, Liu Juan discovered a fabulously rich site in Zanda Canyon, one of the larger canyons in Zanda basin—by now we had figured out a few clues that help in spotting fossils. About a dozen species were jumbled together in a single quarry. One of the best finds is a skull of a large cat. Tseng (married to Liu by now) led the team at the American Museum of Natural History that studied this skull and found that it too is a new species, ancestral

to the tigers and the Tibetan snow leopard. Once again, Tibet turns out to be a crucial place for our understanding of a major group of megafauna—the big cats. From that quarry jumble that Liu Juan discovered, we even unearthed evidence that the Arctic fox, *Vulpes (Alopex) lagopus*, also had an origin in Tibet, finally linking the “third pole” with the north pole.

What else is locked in the secret of this mysterious land called Tibet? Perhaps the ultimate question is: could the woolly mammoth also have come from Tibet? We will never know until fossils are uncovered. The search is on; I wonder if I'll be lucky again next time?

Xiaoming Wang is a curator of vertebrate paleontology at the Natural History Museum of Los Angeles County. In addition to the Zanda Basin, he has led the team on a number of other Tibetan expeditions since 1998. Among his special interests is the evolution of carnivorous mammals. His previous contributions to *Natural History* are “Passing the Smell Test” (May 2012), about skunks, and, with Richard H. Tedford, “How Dogs Came to Run the World” (July/August 2008).

