PALEONTOLOGY

'Fantastic' Fossil Helps Narrow Data Gap

The ancient lakebeds of China's Liaoning Province, renowned for their treasure trove of feathered dinosaurs, have yielded another gem: the complete, fur-shrouded skeleton of the most ancient placental mammal yet discovered. "It is fantastic," says Guillermo Rougier, a paleontologist at the University of Kentucky, Louisville. "The really key point of this specimen is that it's so complete."

The shrew-sized creature—described in this week's issue of *Nature* by Qiang Ji of the Chinese Academy of Geological Sciences in Beijing, Zhexi Luo of the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania, and colleagues—is called *Eomaia*, from the Greek for "dawn mother." It lived during the early Cretaceous period, a time when the world was dominated by the far more varied and numerous dinosaurs. Its age and characteristics place it near the base of the placental-mammal family tree. Although none of *Eomaia*'s own descendants are alive today, scientists say the specimen's beautifully preserved anatomical features can help them pin down relationships among early mammals as well as serve as a reference point for sorting out living placental groups. Luo and Ji's team also argues that the fossil helps resolve differences between the fossil record of mammal evolution and molecular evidence from living groups.

Mint condition. *Eomaia*'s perfect skeleton sheds light on how Mesozoic mammals evolved.

CREDITS: (LEFT TO RIGHT) JI *ET AL.*, *NATURE*; MARK A. KLINGLER/CMNH

Eomaia is the fourth kind of mammal so far discovered in the 125-million-year-old Yixian Formation in Liaoning. The other three belong to extinct lineages of Mesozoic mammals that are distantly related to placental mammals. *Eomaia* is much closer to placentals; features of its teeth place it in Eutheria, the group that includes all the living placentals as well as extinct mammals that are closer to placentals than to marsupials. The next oldest known complete eutherian fossil comes from an animal that lived 40 million years later.

Eomaia's position at the base of the eutherian group gives it far more weight than its estimated 20 grams, paleontologists say. "It really helps us link living placental mammals and extinct Mesozoic groups," Rougier says. When trying to figure out the relationships of placental orders, paleontologists need to know which anatomical traits came from ancestors and which are newly evolved—sometimes an impossible task when the most ancient eutherians were known only from teeth and jaws. Now they can compare traits with the entire skeleton of the most ancestral eutherian, as they do with less ancestral eutherian skeletons from 85-million-year-old rocks in Mongolia.

By pushing back the earliest record of eutherians some 5 million to 10 million years and adding to the known diversity of the earliest eutherians, *Eomaia* also goes a little way toward closing a longstanding gap between fossil evidence and molecular dates for milestones in mammalian history. By studying the genes of present-day animals, molecular geneticists have concluded that eutherians diverged from marsupials 170 million years ago, says Mark Springer, an evolutionary biologist at the University of California, Riverside. The latest molecular data also suggest that modern orders of mammals arose and began to diversify about 104 million years ago—some 40 million years before their undisputed fossil record begins.

By showing that placental mammals had already begun diversifying by 125 million years ago, Luo says, his team's fossil meshes with the molecular evidence. But others say

ScienceScope

More Than MOST A U.S. science delegation met this week with its Chinese counterparts in Beijing, the 10th such meeting in a process that began in 1979. The official agenda touched on ongoing cooperation in a half-dozen areas ranging from energy and agriculture to public understanding of science. But U.S. presidential science adviser John Marburger, leading the first group representing the Bush Administration, added something to the mix: a request that China make the leaders of its burgeoning research enterprise more accessible to outsiders.

"The original agreement was with the Ministry of Science and Technology [MOST], which selects the delegation," says Marburger. "But other ministries have thriving research programs, too, and we want to see whether this umbrella agreement has sprung any leaks and if there are better ways of doing business."

A MOST official said that other ministries are invited as appropriate and that the agenda dictates who will attend. But Marburger says that it might be more efficient to have all the research heavyweights at the table so the two countries could discuss "the big questions."

Academic Discourse Britain's House of Lords has moved to protect researchers from a controversial new export-control law. Academics feared that the law, intended to prevent the export of sensitive technologies to hostile countries, could hamper international science collaboration and training (*Science*, 22 February, p. 1443). Under pressure from the Association of University Teachers and Universities UK, a cross-party coalition of Lords voted last week to add language exempting routine scientific information sharing unless a researcher knew, or should have known, that the information could be used to construct weapons of mass destruction. The amendments would also prevent officials from using the law to restrict the movement of students or researchers.

Science Minister David Sainsbury argued before the vote that the academic freedom clauses could create unwanted loopholes. But academic groups hope that the government will accept the changes when Parliament takes up the proposal later this year.

Contributors: Eliot Marshall, David Malakoff, Jeffrey Mervis, Adam Bostanci

that because *Eomaia* doesn't belong to a modern order, it leaves the major discrepancy unchanged. In that case, paleontologists will have to wait for more gems to emerge from Liaoning or elsewhere. **–ERIK STOKSTAD**

COSMOLOGY

Eternal-Universe Idea Comes Full Circle

The branes are planes and make the cosmos wane. So says a new theory published online by *Science* this week (www.sciencexpress.org). Surprisingly, the theory—an alternative to the standard, inflationary picture of the formation and demise of the universe—describes a sheetlike "brane" universe that eternally dies and rises from its ashes, hearkening back to the long-discarded steady-state model of a cosmos without beginning or end.

"It seems like a consistent philosophical framework. Time is infinite, space is infinite, and they have always been here," says Cambridge University's Neil Turok, one of the authors of the theory. "It's exactly what the steady-state–universe people wanted. Our model really realizes their goal."

The new idea is an extension of the ekpyrotic or "Big Splat" theory, which Turok and other physicists introduced last year as an alternative to inflation (*Science*, 13 April 2001, p. 189). Inflationary theory says that for less than 10^{-30} of a second, the universe expanded at an incredible rate—an idea that can explain features of our universe such as the astonishing similarity of widely separated regions in space and the nature of the cosmic background radiation. Turok, along with Paul Steinhardt of Princeton University and two other colleagues, sought an alternative to inflation based upon the mathematical framework of M theory, a popular successor to superstring theory. The result: the ekpyrotic universe, which describes the birth of our universe in the collision of enormous four-dimensional membranes, or branes. Not only did the ekpyrotic model make similar predictions to inflationary theory, it got rid of the troubling "singularity" of the big bang itself.

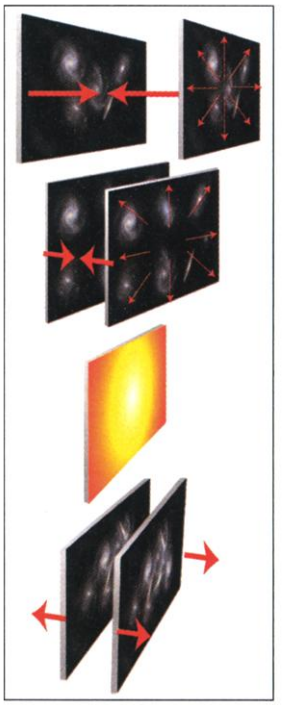
The latest version is a more sophisticated variant of the original ekpyrotic theory. Two infinite branes—our own universe and a "mirror universe"—live a tiny fraction of a meter apart. "If you wait long enough, the branes approach one another," says Steinhardt. They collide, and the energy of that collision creates all the matter and energy in our universe. The membranes "bounce" and separate again. The newborn universe, on its brane, then evolves and eventually burns out.

The theorists were surprised to realize that the collapse-and-bounce process repeats itself ad infinitum. Because the surfaces of the membranes are constantly stretching—thanks to an expansion factor known as the cosmological constant—the "ashes" of each dying universe are diluted and scattered, making it possible to bounce again and again without causing a buildup of brane-bound debris that would end the process. The universe is born, dies, and is reborn again.

The inventor of the inflationary-universe model, physicist Alan Guth of the Massachusetts Institute of Technology in Cambridge, Massachusetts, says the new theory's links to M theory and string theory are "exciting" but don't guarantee its future. "I think it really does come down to the physics of the bounce," Guth says.

To Turok, the new theory is not only mathematically consistent but aesthetically pleasing. "I never had any strong philosophical opinion of this before I worked on it. I was very skeptical of cyclic models," he says. "But as soon as I started working on this, I appreciated that time marched on—that there was no beginning of time." Will the new theory catch on? Time will tell.

–CHARLES SEIFE



No end. In new model, colliding sheetlike "brane" universes stamp out repeated big bangs.

BIODEFENSE

New Anthrax Vaccine Gets a Green Light

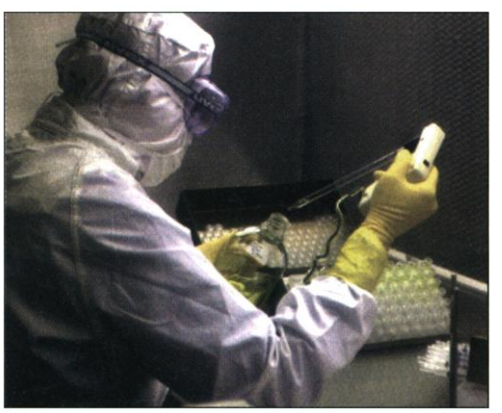
After years of trying to interest people in a new, genetically engineered anthrax vaccine, researchers learned last week that the U.S. government wants to buy one—in a hurry. The National Institute of Allergy and Infectious Diseases (NIAID) in Bethesda, Maryland, announced 18 April that it is seeking bids to develop and test candidates. The Department of Health and Human Services (HHS) plans to follow up with a contract to buy 25 million doses of the winner, to be added to the nation's emergency stockpile. President George W. Bush has already requested $250 million in his 2003 budget for the project.

The only anthrax vaccine licensed in the United States today is a mixture of proteins produced by a tame form of *Bacillus anthracis*, the bacterium that causes anthrax. This anthrax vaccine adsorbed (AVA), as it's called, was developed for animal-hide workers in the 1950s and is now used primarily by the military. Although some claim that AVA causes serious side effects, a panel from the Institute of Medicine concluded last month that it is effective and reasonably safe.

But it isn't ideal for general use, says Carole Heilman, director of NIAID's division of microbiology and infectious diseases, primarily because immunity builds up slowly. Vaccinees require a series of six shots over 18 months, followed by a yearly booster. Instead, NIAID wants a vaccine that requires no more than three shots and that would work so rapidly that it could be given after exposure to anthrax spores.

Researchers have been exploring many alternatives to AVA. But because speed is of the essence, says Heilman, NIAID has decided to go with the most extensively tested new vaccine: one based on a protein in the bacterium's toxin complex called protective antigen (PA). This protein is part of the mélange present in AVA, and researchers believe that it is the main contributor to protection. However, they don't know how potent a vaccine based on PA will be in humans. Studies by Arthur Friedlander and others at the U.S. Army Medical Research Institute of Infectious Diseases in Fort Detrick, Maryland, have shown that recombinant PA, produced by non–spore-forming *B. anthracis*, protects rhesus monkeys against inhalational anthrax; they also suggest that fewer injections of the vaccine might suffice to elicit immunity and that the vaccine might have fewer side effects than AVA.

Some say the choice for injected PA is needlessly conservative, citing other, more promising approaches. "It's very disappointing that [NIAID] is sticking to the tried and true," says Uma Ryan, CEO of AVANT Im-



Yesterday's vaccine. The government wants a modern successor to AVA for the civilian population.

CREDITS: (TOP TO BOTTOM) C. SLAYDEN WITH IMAGES FROM NASA; SHAWN JACOBSON/AP