

that the annual funding available for research grants could drop from its current level of \$92 million to \$27 million in 2017. The only way to avoid such a drastic decline was to phase out support to some older facilities. The panel has identified cuts of about \$20 million a year.

Not surprisingly, managers of the facilities on the chopping block (NSF prefers the term “divestment”) are very unhappy. The two organizations responsible for operating GBT and VLBA—Associated Universities Inc. and the National Radio Astronomy Observatory—issued a statement pointing out that the two telescopes were not “obsolete facilities” that could be retired to make way for new ones. “Both the GBT and the VLBA are the state-of-the-art, and have crucial capabilities that cannot be provided by other facilities,” the statement said. Karen O’Neil, GBT’s site director, adds that divesting the instrument “will be a serious blow to astronomers across the United States and around the world.”

The proposed divestment “will undoubtedly be devastating to the radio and optical communities,” says Debra Elmegreen, an astronomer at Vassar College in Poughkeepsie, New York, who served on the decadal survey committee and is past-president of the



“Not obsolete.” Supporters say the 10-year-old Green Bank Telescope (left) and the Very Long Baseline Array (right) produce irreplaceable, cutting-edge science.



American Astronomical Society. “But there is simply no way that all worthy facilities can be kept operating on federal funds and still have any funds left for new starts,” she says. The panel’s report had done a good job of finding what she calls a “prudent balance among small, medium, and large efforts, and between existing and proposed facilities.”

David Silva, director of the National Optical Astronomy Observatory, expects to find alternate funding sources for the three telescopes that the panel has recommended for divestment. For instance, the 4-meter Mayall Telescope is expected to recover some of the lost funding as part of BigBOSS—a dark energy survey project led by a team at the Department of Energy’s Lawrence Berkeley National Laboratory.

At the same time, he says, university researchers will suffer if NSF ends funding for the Kitt Peak telescopes. “My num-

ber-one concern is that these telescopes represent 700 nights of peer-reviewed open-access time available to university researchers,” Silva says. Operating the instruments without NSF support would likely mean ending open access and dedicating them to specific missions such as the dark energy project. “It does disenfranchise a community” that has been using the telescopes for many years, Silva says.

The panel authors say new telescopes should help to compensate for some of these losses. One of its recommendations is that NSF should start building the \$665 million LSST in 2014. The money would come from a separate account outside the astronomy division.

It’s not just the defunded facilities that would suffer the consequences of a shrinking budget, Eisenstein says. “Most, if not all, aspects of the field will have to face some reductions,” he says. An across-the-board decline in research funding is inevitable: Even with the termination of funding to GBT, VLBA, and other telescopes, the panel projects a possible reduction in grants from the current level of \$92 million per year to about \$70 million a year later in the decade.

—YUDHIJIT BHATTACHARJEE

CHINA

Dinosaur Kingpin Opens Fossil Bonanza to Science

PINGYI, CHINA—When Zheng Xiaoting read a report in *Science* 2 years ago arguing that *Archaeopteryx* and an ancient bird unearthed in China, *Confuciusornis*, were poor flyers, he was dubious. The Shandong Tianyu Museum of Nature here has more fossils of *Confuciusornis*, a crow-sized bird from the Cretaceous period 120 million years ago, than everywhere else in the world put together. Zheng, the museum’s director, acquired every one of Tianyu’s 606 *Confuciusornis* specimens himself. The *Science* paper argued that the central shaft, or rachis, of the bird’s primary feathers was too narrow for powered flight. But in the few specimens at Tianyu with an intact rachis, the shaft was twice as thick. In a comment in *Science* (15 October 2010, p. 320) authored with colleagues from the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP)

in Beijing, Zheng wrote that the claim that the birds were incapable of sustained flight needed to be “further evaluated based on newly collected, more accurate data.”

Not bad for a high school dropout.

Here in this small town in Shandong Province, an hour’s drive from the birthplace of Confucius, Zheng, 59, has single-handedly built one of the most important fossil collections in the world. In a complex dominated by a palatial main building resembling the Great Hall of the People in Beijing, Zheng has gathered at last count 1106 dinosaur specimens, including hundreds of feathered dinosaurs from northeastern China. “It’s an amazing collection,” says IVPP Director Zhou Zhonghe. Another 2328 specimens are primitive birds, including the unrivaled assemblage of *Confuciusornis*, named of course after the renowned philosopher. Having

many specimens of relatively few species, Zhou says, means “you have a whole range of ages,” from hatchlings to adults, making it possible to view a species’ full life cycle and analyze it statistically.

This treasure in the countryside is beginning to draw paleontologists from near and far. Zheng has forged collaborations with two research powerhouses—IVPP and the Nanjing Institute of Geology and Palaeontology—and helped found and now directs an institute at nearby Linyi University. Else Marie Friis, a paleobotanist at the Swedish Museum of Natural History in Stockholm, has visited twice to study Mesozoic plant specimens. Paul Sereno, a paleontologist at University of Chicago, has also come here two times to study *Sinosauropteryx prima* and Jeholosaurus, feathered dinosaurs from the early Cretaceous. One of the few orna-

ments on Zheng's desk is a memento from Sereno: a 15-centimeter-long thumb claw of *Suchomimus tenerensis*, a 110-million-year-old meat-eating dinosaur that Sereno discovered in the Sahara Desert.

Compared with most museums, which build up collections over decades, Tianyu rose to prominence in the blink of an eye. Zheng's first love was rocks, and some of Tianyu's most valuable holdings he acquired include uncut diamonds, the world's largest turquoise, and other mineralogical wonders. He then started buying up fossils, until a national law introduced in 2008 clamped down on China's fossil trade. Over 15 years, Zheng spent, by his own reckoning, 360 million RMB—more than \$50 million—on Tianyu's holdings and the museum buildings, of which the entirety now belongs to the county. His biggest fossil splurge was an exquisite *Anchiornis* specimen, a tiny birdlike dinosaur that lived 160 million years ago—around the time that birds branched off from dinosaurs—for which Zheng forked out about \$150,000. "I recognized immediately that it was unique," he says.

For that kind of spending spree, it wouldn't hurt to own a gold mine. Or, in Zheng's case, to have been director of a government-owned gold mine. Zheng accrued Tianyu's holdings during his years at the helm of the nearby Guilaizhuang gold mine. When a Shandong company took over the mine in 2007, Zheng retired to devote himself to the museum. He now spends his days examining fossils, dissecting animals to study anatomy, and assembling skeletons of modern birds such as falcons and ostriches. "I compare him to a naturalist from the 18th century," Zhou says.

An improbable one at that. In 1969, during the Cultural Revolution that devastated China's education system, Zheng bailed out of school at age 16. "I was ready to join the army but my father wouldn't let me," he says. He got a job in a clothing factory. A model worker, Zheng ascended the Communist Party ranks, becoming party secretary of a town in Pingyi in 1988. Three years later, he got the plum job at Guilaizhuang and earned a fortune.

Zheng burst onto the paleontology scene in 2008, after a retired IVPP professor, Dong Zhiming, visited Tianyu and reported back

about the breathtaking fossils. Later that year, Zhou came to see for himself, and although at first he had trouble understanding the rapid talker with a thick Shandong accent, he was impressed. "For a nonprofessional, he's an excellent researcher," Zhou says. If Zheng had amassed the fossil trove as a private collection, held to appreciate in value like artwork, the paleontological world would have been much poorer. "To me, the most important thing is that he is keeping these specimens safe," Zhou says.

In a few short years, Zheng has built a publication record most Ph.D.s can only dream of. Feathers in his cap include reports

teryx in fact was not the first bird—a hotly debated claim.

Tianyu is a study in superlatives. In one of the museum's public halls, visited by 90,000 people last year, several dozen fossilized nests are arrayed in a low glass case several meters long and a few meters wide. "I've never seen so many dinosaur egg nests," Zhou says. Another room is filled with ichthyosaurs and other Mesozoic marine reptiles. Tianyu's 28,000 square meters of exhibition space brag of six Guinness World Records, including biggest dinosaur museum, the largest *Sinosauropteryx* specimen (3.8 meters long), largest amethyst geode (3 meters long), and



Birds of a feather. Zhou Zhonghe (foreground) and Zheng Xiaoting examine a feathered dinosaur fossil in Tianyu's research wing. One of the more stunning specimens in the museum is this *Protopteryx*, an early bird from the Cretaceous.



in *Nature* on an early Cretaceous dinosaur, *Tianyulong confuciusi*, with primitive featherlike structures and another on early feathers, and a report in the *Proceedings of the National Academy of Sciences* on fossil evidence of an avian crop from the early Cretaceous. Zheng has a grant from the National Natural Science Foundation of China to study Jehol biota fossils from the early Cretaceous. And when China's premier dinosaur hunter, IVPP's Xu Xing, described a new feathered dinosaur from one of Tianyu's Jurassic specimens in *Nature* last year, he named it *Xiaotingia zhengi* after the museum's patron. The birdlike dinosaur may have lasting significance. Based on the find, Xu argues that *Archaeopteryx* and *X. zhengi* resemble two carnivorous dinosaurs, velociraptor and microraptor, more than birds, so *Archaeop-*

the longest silicified tree trunk (38 meters long). Its 338.6-carat diamond is the largest in Chinese history. Then there is the world's biggest cache of crinoids, 35-million-year-old marine echinoderms whose fossils resemble delicate flowers.

To Zhou, some of the most eye-popping specimens are in the research wing. IVPP scientists, he says, could spend years picking through Tianyu's treasures. "Hundreds of papers will come out of this museum," he predicts, on finds such as dinosaur-bird transition species and on feather development. That assessment is based on Tianyu's current magnificent holdings—which are unlikely to multiply by much. As Zheng says, smiling, his arms spread wide and hands palms up, "I've run out of money."

—RICHARD STONE