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SCIENCE FILE

Dinosaur had lots of teeth to spare

Sauropods had as many as nine backups per tooth socket, new research shows.

By Brad Balukjian

Dinosaurs almost bankrupted the tooth fairy. New research shows that the lumbering plant-eaters called sauropods produced new teeth as often as twice per month and had up to nine backup teeth in a single tooth socket.

While the fearsome *Tyrannosaurus rex* is known as the king of the dinosaurs, the sauropods were the real royalty. These creatures, including the childhood favorite *Apatosaurus* (previously known as *Brontosaurus*), were the largest animals that ever lived on land.

"A big *T. rex* is maybe 40 or 45 feet tall, but a big sauropod pushes 100 feet long or more," said Michael D'Emic, a vertebrate paleontologist at Stony Brook University in New York and lead author of the teeth study published Wednesday in the journal *PLOS One*.

Having never let go of a childhood fascination with dinosaurs, D'Emic wondered how the enormous size — and hence diet — of sauropods may have affected the evolution of their jaws and teeth. Since they were avowed vegetarians, D'Emic assumed their teeth would be well worn from munching copious amounts of tough plant matter.

To investigate, he and his team scoured dozens of museum collections in search of sauropod jaws. Teeth were easy to come by, but persuading a museum curator to let him tear apart an entire jaw was difficult.

"I had to search collections for jaws that had a lot of teeth but that were ratty or fragmentary," D'Emic said.

He lucked out, finding a *Camarasaurus* jaw dug up in southern Utah and a *Diplodocus* jaw from Colorado. Both animals lived about 150 million years ago in the Jurassic period, and were types

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SkyWorks Digital

A STUDY looking at short gamma-ray bursts in space suggests all the gold on Earth — indeed, in the cosmos — came from colliding dead neutron stars in cataclysmic events that occurred long ago.

Tapping a cosmic vein

Astronomers say colliding neutron stars could potentially account for all the gold in the cosmos.

Genetics and obesity

Researchers connect a gene variant linked to weight gain with a hormone that causes hunger.

A coffee fix in space?

Scientists design a cup that uses capillary action to safely deliver astronauts their morning joe.

of sauropods that lived side by side.

The next step was to break apart the jaws and remove not only the 30-odd visible teeth individually, but whatever backups were embedded in the sockets below.

In other words, he needed to pull some teeth. "That had to be done by a professional — somebody with a surgeon's hands and patience," D'Emic said.

Patience indeed. Behind every visible tooth, the *Cam-*

arasaurus had three backup teeth lined up and ready for use. The *Diplodocus* had even more — five spares behind each visible tooth.

It took six months for the dino-dentist to extract the teeth, embed them in a special resin, saw them up, mount them on slides, sand and polish them by hand and then photograph them for study.

In addition to the large number of teeth in the pipeline, D'Emic and his team

were interested in how quickly those teeth would come in.

Cross-section images revealed lines in each tooth's dentin, the layer below the enamel. Since a new layer grows each day, the researchers could figure out the age of a tooth by counting those lines, much like counting rings on a tree stump. And by looking at the intervals in age between successive teeth in a socket, they could estimate how

quickly teeth were replaced. *Camarasaurus*, with its larger, broader-crowned teeth, had a new tooth come in about once every two months. *Diplodocus*, with smaller, narrower teeth, had a replacement about once a month.

When the scientists used a mathematical model to extrapolate their findings to other types of sauropods, they estimated that one genus called *Nigersaurus* replaced its teeth every two

weeks, with nine spares for every tooth.

D'Emic also noticed that more recent sauropods had evolved smaller, narrower teeth that got replaced a lot faster, like *Diplodocus*. He wondered: Why the shift?

Sauropods didn't actually chew their salad — they clipped it off with their teeth and then swallowed it whole. Perhaps having teeth turn over faster kept them fresh for the hard work of cutting vegetation off trees or bushes, D'Emic said.

Another theory is that given the limited utility of its teeth, *Diplodocus* invested its bodily resources in other tissues, preferring a quantity-over-quality approach.

"All the tooth had to do was snip," D'Emic said.

Finally, there was the question of how two plant-eating dinosaurs the size of a mega-yacht could coexist in the same environment. D'Emic thinks the answer lies in the teeth.

If *Diplodocus* grazed vegetation close the ground, it would have accidentally eaten a fair amount of dirt — and the sauropod's narrow teeth could have been an adaptation for this grittier diet, he said. With *Diplodocus* eating plants down low, *Camarasaurus* could have foraged up high, providing enough room for everyone.

Paul Sereno, a University of Chicago paleontologist who was not involved in the study, said he found D'Emic's argument convincing.

"Last night I had a salad that I grew in my own yard for the first time, and I really had to wash the lettuce carefully, because there's this grit in it," said Sereno, who also studies sauropods. "It's exactly what we're talking about. You put your muzzle down to the ground and you're going to be incorporating these sand grits that wear your teeth down."

brad.balukjian@latimes.com

Coroner confirms girl was alive when hit

[SFO, from AA1] case in recent U.S. history of a passenger being fatally struck by rescuers after a crash-landing. They said it will require a significant re-evaluation of how crews handle crashes.

The experts said rescuers at San Francisco International Airport acted with the best of intentions: Training tells them that the most dangerous aspect of a plane crash is the fire and that extinguishing it as quickly as possible should be the top priority.

"The first thing you want to do is get the fire out to protect the victims," said Tom Wiczorek, director of the Center for Public Safety Management at the International City/County Management Assn. based in Washington, D.C.

Jet fuel burns at 1,800 degrees Fahrenheit, and it will burn through the plane exterior's aluminum and its fire-

retardant insulation within three minutes, said Fred Cnota, an Aircraft Rescue Fire Fighting commander at Chicago O'Hare International Airport.

"It's a lot of thinking on your feet, and you've got to have eyes in the back of your head. You're trying to cross runways, and you have to get there fast ... before the fire is inside the cabin," he said. Referring to the passengers, he added: "If you're inside the cabin when it starts burning, you're dead."

The Federal Aviation Administration requires that the first crash rig be on the scene within three minutes and the last within four, Cnota said.

Many deaths in previous crashes occurred among people who survived the initial landing but died in the subsequent fire.

But in this case, many Asiana passengers managed to exit the plane before the fire spread and were walking on the tarmac. It's unclear how the victim, Ye Mengyuan, got to a space near the left wing of the plane following the July 6 crash-landing at the airport. Ye was one of three passengers killed. It was not clear how her body ended up near the plane's wing, the coroner said, adding it was "speculative" that she was thrown from the plane. She was on the ground when she was struck by the vehicle.

A San Francisco Police Department spokesman said last week that the girl was outside the plane and covered in fire-retardant foam when the fire truck "went over her."

Wiczorek said the Asia-



Associated Press

YE MENGYUAN, 16, was one of three Asiana passengers who died.

na incident shows that officials need to look at the way rescuers approach crash sites and answer the big question: How can you spot a survivor despite all the chaos of burning wreckage, debris all over the airfield, and a blanket of foam possibly covering people?

"Is it putting infrared devices on a vehicle that may spot a warm body, even if it is covered?" he asked.

Part of the problem is the thickness of the fire-extinguishing foam. "It's almost like a bubble bath ... you could easily lose something in the foam blanket," said Miami International Airport Division Chief Stephen Kilby of Miami-Dade Fire Rescue.

"This is a nightmare," Kilby said of the situation.

"We realize as the wreckage is scattered, people can unfortunately be scattered as well. We train for things like this, but sometimes, if something like that were to happen, I'm not sure that it's avoidable," Kilby said.

Wiczorek said that until recent years, rescuers would not have faced that issue be-

cause planes tended to explode during crash-landings. But the development of fire-resistant materials in planes in recent decades has increased survivability in hard landings such as the one at SFO.

Another issue is visibility. Cnota said that in his unit, the driver can have difficulty seeing through the ARFF's sides and rear. He trains drivers to avoid situations where they have to back up because it can be hard to see.

Wiczorek, a former fire chief in Michigan, said firefighters at airports train for such situations, "but nothing prepares you for what you encounter on a scene like this. No matter how hard you train, something is always different."

The San Francisco fire chief called Ye's death a "tragic accident" and said in a news conference the incident was still under investigation.

Hayes-White, surrounded by members of her command staff, said the coroner's confirmation of Ye's cause of death was difficult for her department.

"It was very hard to hear," she said. "Devastating, heartbreaking — there are not a lot of words to describe how badly we feel, how sorry we feel for it."

Firefighters responding to the crash came upon a "very volatile, dangerous situation," Hayes-White said.

Debris from the crash was strewn about the runway, and fuel leaked from the plane, she said. When they arrived, the plane was still engulfed in flames, she said.

"It was a difficult, challenging scene," she said.

The department will evaluate its protocols and see how it can improve its responses, she said.

"Everyone is very emotional from this incident," Hayes-White said of her department. "Getting the news yesterday has made it very difficult ... we go to work every day to save lives. Many lives were saved July 6 ... however, I don't want to take away from the loss of the three lives."

Hayes-White said her department made a "valiant effort" to save lives. The San Francisco Police Department and National Transportation Safety Board are investigating the incident, she said.

There were numerous emergency vehicles in the area, and neither Hayes-White nor Foucraut would comment on whether Ye was struck by multiple vehicles, saying that was part of the police investigation.

Hayes-White would not comment on whether the department could face civil or criminal liability for Ye's death, saying, "I'm not a legal expert."

San Francisco International Airport has four ARFFs.

San Francisco Mayor Ed Lee said he was "profoundly saddened by the involvement of a responding emergency vehicle in the death" of Ye. "We deeply mourn the loss of Ye Mengyuan, with her family and friends," he said.

ron.lin@latimes.com
hailey.branson@latimes.com
ari.bloomekatz@latimes.com

Lottery results

Tonight's Super Lotto Plus
Jackpot: \$34 million
Sales close at 7 p.m.

Tonight's Powerball Jackpot:
\$141 million
Sales close at 7 p.m.

For Friday, July 19, 2013

Mega Millions
Mega number is bold

16-20-24-39-42—Mega 46
Jackpot: \$12 million

Fantasy Five: 9-13-25-29-36

Daily Four: 5-1-6-5

Daily Three (midday): 8-0-6

Daily Three (evening): 0-7-5

Daily Derby:

(9) Winning Spirit
(6) Whirl Win
(8) Gorgeous George
Race time: 1:42.65

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General information:

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(Results not available at this number)

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