Newly Hatched Dinosaur Babies Hit the Ground Running

BOCA RATON, FLORIDA—From 27 July to 1 August, animals with a backbone drew the attention of morphologists, evolutionary biologists, and other researchers.

Therizinosauroid dinosaurs grew up fast. When they chipped their way out of an egg, the animals emerged strong-legged, ready to fend for themselves and find food, according to an analysis of 80-million-year-old fossil dinosaur eggs conducted by a team of paleontologists and developmental biologists.

For the past 6 years, Arthur Cruickshank of the University of Leicester, U.K., Martin Kundrát of Charles University in Prague, Czech Republic, and their colleagues have studied the jumbles of bones and teeth packed into a dozen fossil eggs found in Henan Province, in east-central China. The teeth and bones allowed them to identify the fossils as theizinosauroid, Kundrát reported.

Now, by comparing the dinosaur embryos with embryos of birds and alligators, Kundrát has determined how far along in development each embryo was and has begun to piece together how therizinosauroid young grew to be independent. To do this, Kundrát's team enlisted the help of Terry Manning of Rock Art in Leicester, who spent several years removing the eggshells, etching out the rock inside, and exposing the fossils. The results of Manning's efforts are impressive and provide unprecedented details about dinosaur embryos, says Eric Snively, a paleontologist at the University of Calgary, Canada.

A good egg. This fossil embryo revealed many secrets about one dinosaur's early life.

Manning and Cruickshank first documented the amount of yolk in each egg and the position of each dinosaur embryo. Because the amount of yolk packed around an embryo decreases over time, the degree to which the embryo is squished inside the eggshell is a rough indicator of the embryo's age.

Kundrát got an even better sense of each embryo's developmental age by using the porosity of the fossilized dinosaur skulls, limb bones, and backbones as a guide. A skeleton starts out soft and porous and gradually hardens into bone, so the degree of ossification typically reflects the age of an embryo. Using the known morphology and hardness of alligator bones at different points in embryogenesis, Kundrát was able to sharpen his age estimate for each dinosaur embryo.

Kundrát determined that all the dinosaur embryos were at least two-thirds of the way through their development, and parts of their skeletons were much further along than those of comparably aged alligator embryos. For example, the dinosaur vertebrae were less porous than expected. "They had well-ossified limb bones, so they can walk immediately after hatching," says Kundrát.

As part of their study, Kundrát and his colleagues also gathered the fossilized teeth of the embryos. Those from the youngest embryos resemble the teeth of the other theropods and were well suited for eating meat. In the more mature embryos, although the teeth retained some meat-eating potential, they were more like those seen in adult therizinosauroids, which are presumed to be herbivores. "We could see the transition of the tooth crown and cusp," Kundrát said.

These data suggest that the hatchlings came out of the egg able to chase down prey and consume suitable plants, Kundrát reported. He suggests that these stages of tooth development reflect the evolutionary steps that allowed therizinosauroids to arise from carnivorous ancestors.

"I'm glad to see this [embryo work] done," says Zhe-Xi Luo, a paleontologist at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania. In addition to their embryos, he notes, the eggs are important in their own right, because they hint at another aspect of the dinosaurs' lives. Until recently, the only adult remains of therizinosauroids in the Far East have been found near Mongolia, about 1,000 kilometers from the site where the eggs were found. This suggests to Luo that these dinosaurs migrated great distances or that they were much more widespread than paleontologists had thought.

Tiny Salamanders Show Their Teeth

For such small animals, salamanders belonging to the *Thorius* genus have posed a big problem: Biodiversity experts can't easily tell different species apart, because many of them look identical. That makes it difficult to count species or understand the animals' evolutionary history. Now, James Hanken of Harvard University has used genetics to classify the animals and place them on a family tree that illuminates the morphological history of the genus. As Hanken reported at the meeting, the tree suggests that a few *Thorius* species have turned back the evolutionary clock, reacquiring traits—including teeth—that their earliest ancestors had lost.

The miniature salamanders, which are native to Mexico, live on moss and inside bromeliads and fallen logs. Hanken, who began studying the animals 30 years ago, has always been fascinated by their size. Although some are much larger, certain *Thorius* species have bodies just 13 mm long, making them the tiniest tailed tetrapods. Packing all the necessary organs into a body that size poses a challenge. "[They] are right up against the edge of vertebrate design," says Hanken. They can't be much smaller, agrees Johan van Leeuwen of Wageningen University in the Netherlands.

Hanken originally thought there were fewer than a dozen *Thorius* species, but by looking for slight genetic differences that readily distinguish one species from another, he and his colleagues quickly identified 14 new species. His group recently added eight more to the list. "Every trip we take, we find one or two new species," says Hanken.

Those results answered one longstanding question: In part because there's little room in those tiny bodies to move parts around, researchers have wondered whether the small size of *Thorius* salamanders would

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