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Blood from a golden stone: dinosaur discoveries within amber

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ABSTRACT

Beautiful prehistoric flower petals, pristine exoskeletons of insects, delicate silken spiderwebs, and even entire desiccated carcasses of small lizards have been discovered inside amber. But until recently, even the largest pieces of amber seemed too small to contain a dinosaur.

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In his novel *Jurassic Park*, Michael Crichton envisioned dinosaurs being cloned using DNA from the blood inside ancient mosquitoes preserved within amber. Amber is a fossilized tree resin (not sap) that often contains plant and animal remains and protects them from many forms of decay. Beautiful prehistoric flower petals, pristine exoskeletons of insects, delicate silken spiderwebs, and even entire desiccated carcasses of small lizards have been discovered inside amber. But until recently, even the largest pieces of amber seemed too small to contain a dinosaur.

The first known dinosaur fossils within amber were collected in Alberta, Canada, and reported in 2011. They were not whole dinosaurs, but just partial dinosaur feathers. It is now well-established that feathers appeared long before birds evolved from among small meat-eating dinosaurs. Many dinosaur species are known to have had feathers, and there are many ways feathers can be trapped in tree resin. More recently, one tiny piece of amber shocked the paleontological community. It comes from northern Myanmar, a region long renowned for amber with inclusions that date back roughly 99 million years to the Late Cretaceous. The piece contains many fossils, including prehistoric ants and flakes of bark, but the most important is nothing less than a section of dinosaur tail! The tail segment comes from near the tip, and probably became encased in the resin after the death of its owner. The tail is completely covered in feathers and belonged to a dinosaur intermediate in size between a sparrow and a chicken.

Although the phrase “tiny dinosaur” may seem oxymoronic, modern paleontologists have a growing appreciation for how many different kinds of tiny dinosaurs there actually were. However, the researchers who described the tail segment, led by Lida Xing of China University of Geosciences, had to rule out the possibility that the specimen belonged to a bird. Birds were already present in the Cretaceous. Some other amber specimens from the Late Cretaceous of Myanmar enclose avian feathers and wings, and even, in one case, the near-complete body of an unlucky fowl. However, the tail segment can be identified as almost undoubtedly non-avian. The tails of birds, like those of some of their closest dinosaurian relatives, bear fans of broad, leaf-shaped feathers that can produce aerodynamic forces useful in flight. Furthermore, in all modern and most fossil birds, the portion of the tail formed by flesh and bone is short, with feathers making up the rest. The amber tail segment, by contrast, clearly belonged to an animal with a longer tail skeleton. There *are* prehistoric birds with such tails, but they appear to have been confined to the Jurassic and Early Cretaceous and are still extended by broad, flight-assisting feathers. Not so with the amber tail. Its short, pliable feathers are like a shaggy coat – suitable for holding in body heat, but useless for flight.

To facilitate identification of this feather-shrouded tail fragment, CT scans, and an analysis of its chemical composition were produced using a synchrotron. This analysis revealed eight tail vertebrae that could be attributed to some kind of little meat-eating dinosaur. Probably, one less bird-like than *Velociraptor* and looking similar to the more primitive *Compsognathus*.

Surprisingly, small amounts of iron associated with the bones and feathers are probably a residue of hemoglobin from dinosaur blood! Does that remove the need for a mosquito middleman and put us on track for dinosaur cloning? Unfortunately not, given the vast gulf between hemoglobin-derived iron and intact dinosaur DNA. Despite having been sealed in amber rather than fully exposed to decay, any genetic material in the residue would be too fragmentary for even the theoretical prospect of reassembly into a dino genome.

More importantly, the tail reveals an entirely new feather type. In modern bird feathers, filaments (barbs) branch symmetrically off a sizeable hollow shaft (rachis). These barbs have their branching filaments (barbules), which hook onto the barbules of neighboring barbs in Velcro-like fashion. The amber tail feathers each have a solid shaft, with barbs that branch in an alternating (rather than symmetrical) pattern, and hookless barbules. Such feathers do not fit neatly into previous models of feather evolution. They indicate that dinosaurs evolved a variety of feather types for different functions, such as insulation and display. The evolutionary history of feathers was not a straight line. Instead of progressing from simple hair-like filaments to the elaborate aeronautic plumage of modern birds, the history was as complex and multi-branched as feathers themselves.

This discovery also shows the potential of what might be found in the future. Before this discovery, the idea of a dinosaur encased in amber would previously have been considered too far-fetched even for science fiction. In the coming years, more amber specimens will be collected and scrutinized in Myanmar and elsewhere. This time, we got a tail. Next time, it could be a head.