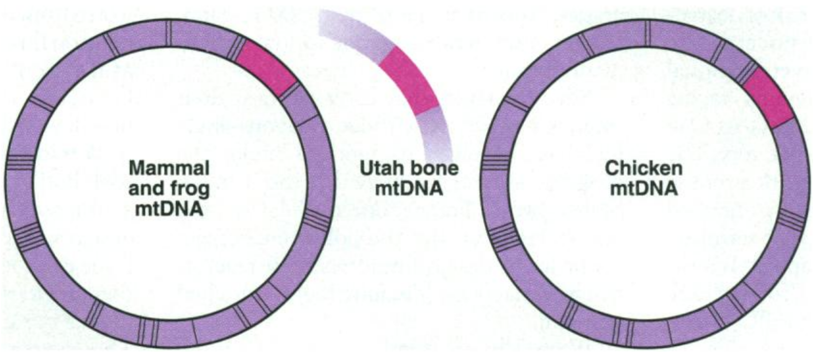
PALEONTOLOGY

Possible Dino DNA Find Is Greeted With Skepticism

As a boy, geneticist Scott R. Woodward often sat on a fossilized dinosaur footprint his grandfather had found in a coal mine in Utah. So last year, when Woodward, who runs a lab for studying ancient DNA at Brigham Young University in Provo, Utah, decided he wanted to try to find DNA from dinosaurs, he knew where to look for dinosaur bones. He asked a high school friend, a geologist at a mine in their hometown of Price, Utah, to call him if the miners found any unusual bones.

Woodward reasoned that coal beds, which are formed from ancient peat bogs, would keep the bones preserved from the DNA-degrading effects of oxygen. His hunch may have been correct. On page 1229, Woodward and his co-authors report extracting DNA from two 80-million-year-old bone fragments of a large skeleton found in the roof of the mine. He's convinced the DNA is extremely old and "likely" to be from a dinosaur, as the DNA sequence is unlike that of any modern animal. "This is like nothing we've ever seen before," says Woodward.

But that uniqueness cuts both ways. If Woodward does indeed have dino DNA, many researchers think, its sequence should bear at least some resemblance to the DNA of dinosaurs' presumed modern relatives, birds or crocodiles. Other critics wonder if the DNA is actually ancient at all. Some researchers, including Svante Paabo, a molecular evolutionist at the University of Munich who is a pioneer in the study of ancient DNA, are skeptical that the fragile molecules could exist in bone for 80 million years. "It's a very surprising finding," says Paabo. "The jury is still out until others can reproduce his results."



Muddle in the middle. The cytochrome b sequence *(pink area)* from ancient Utah bones doesn't group with mitochondrial DNA (mtDNA) from any living creature, making it hard to classify as dinosaur or non-dinosaur genetic material.

The bones Woodward studied were embedded in a layer of sandstone that has been reliably dated to the Cretaceous period, 80 million years ago—a time when the only large animals were dinosaurs. Woodward collected 15 fragments from two bones. Back in his lab, he took samples from their interiors, which should have been protected from exterior contamination, and extracted DNA from them. The next step—the crucial one—was to produce a readable DNA sequence. Reading the sequence was the only way to find out whether the DNA was old and uncontaminated by a modern organism.

To do so, Woodward had to make copies using the polymerase chain reaction (PCR). In PCR, an enzyme called a polymerase rolls along the original DNA, making a mirror-image copy by stringing together nucleotides that complement the original sequence; the process is repeated many times to yield enough of a particular DNA sequence to work with. But missing or damaged nucleotides in the original template create gaps that can stall the reaction. And the nucleotides of old DNA are unlikely to be in the best shape.

After thousands of attempts, Woodward's team finally came up with nine different sequences from a stretch of DNA known as the cytochrome B gene (*cyt b*), which is from the cellular organelles called mitochondria. The differences among these nine sequences, which were all at least 134 bases long, may occur in part because they came from two different animals—or the PCR may have made mistakes as it copied the damaged DNA.

Woodward's team actually tried to amplify several different types of DNA from the bone; they were only able to produce copies of *cyt b* mitochondrial DNA (mtDNA), perhaps because mtDNA is the most abundant type of DNA in the cell, Woodward speculates. But *cyt b* is "a good place to start," says Wayne State University evolutionary geneticist Edward Golenberg, who has recovered 20-million-year-old DNA from an ancient magnolia leaf. He explains that there are extensive databases at GenBank and the European Molecular Biology Laboratory containing the *cyt b* sequences from a wide range of modern animal species. Therefore Woodward could compare his sequences to those in the banks to see if he pulled out an ancient or modern molecule.

When Woodward made that comparison he found that his nine sequences didn't look like modern bacterial or human sequences, which would be signs of contamination. And the ancient DNA was at least 30% different from the sequences of modern birds, reptiles, and mammals. He says: "Based on these fragments, we can't say if it is closest to a bird, mammal, or reptile." Though many paleontologists think any dinosaur DNA should look something like bird DNA, Woodward turns that argument around. Perhaps, he suggests, there were many different species and genera of dinosaurs that may have had DNA entirely different from modern species. Alternatively, he says, enough time may have passed so that the fast-evolving mtDNA could have changed dramatically by the time it was inherited by the dinosaur's modern relatives.

American Museum of Natural History avian systematist Joel Cracraft is dubious. Because dinosaurs are thought to be ancestral to birds, the DNA "should be closer to birds than to anything else," he says. Cracraft thinks Woodward should be able to show how, through the gradual substitution of DNA bases over the millennia, the Utah sequences could evolve into sequences similar to those found in modern birds. If Woodward can't show this, Cracraft says, what he's found isn't a dinosaur.

Others warn that the odd sequences may be the result of a PCR mistake. Rather than dinosaur DNA, Woodward could be amplifying DNA from an ancient, unknown micro-organism that was hidden in the bones. Or, the copying polymerase stumbles across a base on the original that is so damaged it cannot identify it, and randomly substitutes another base. Those substitutions may account for the variation Woodward sees in his sequences.

But if other labs repeat this work and come up with the same sequences, Paabo says, that would erase many doubts about contamination. And Woodward is even now dividing up the remaining fragments of bone to send to other labs. Unfortunately, he cannot get more, because the ceiling of the tunnel collapsed, shutting down that portion of the mine. But that shouldn't stop others from trying to duplicate the analyses. "I think the significance of his work is that it will spur more people to look for more of these ancient samples of DNA," says Golenberg. Those samples will be truly significant, however, only if scientists can ascertain the animal from which they came.

–Ann Gibbons