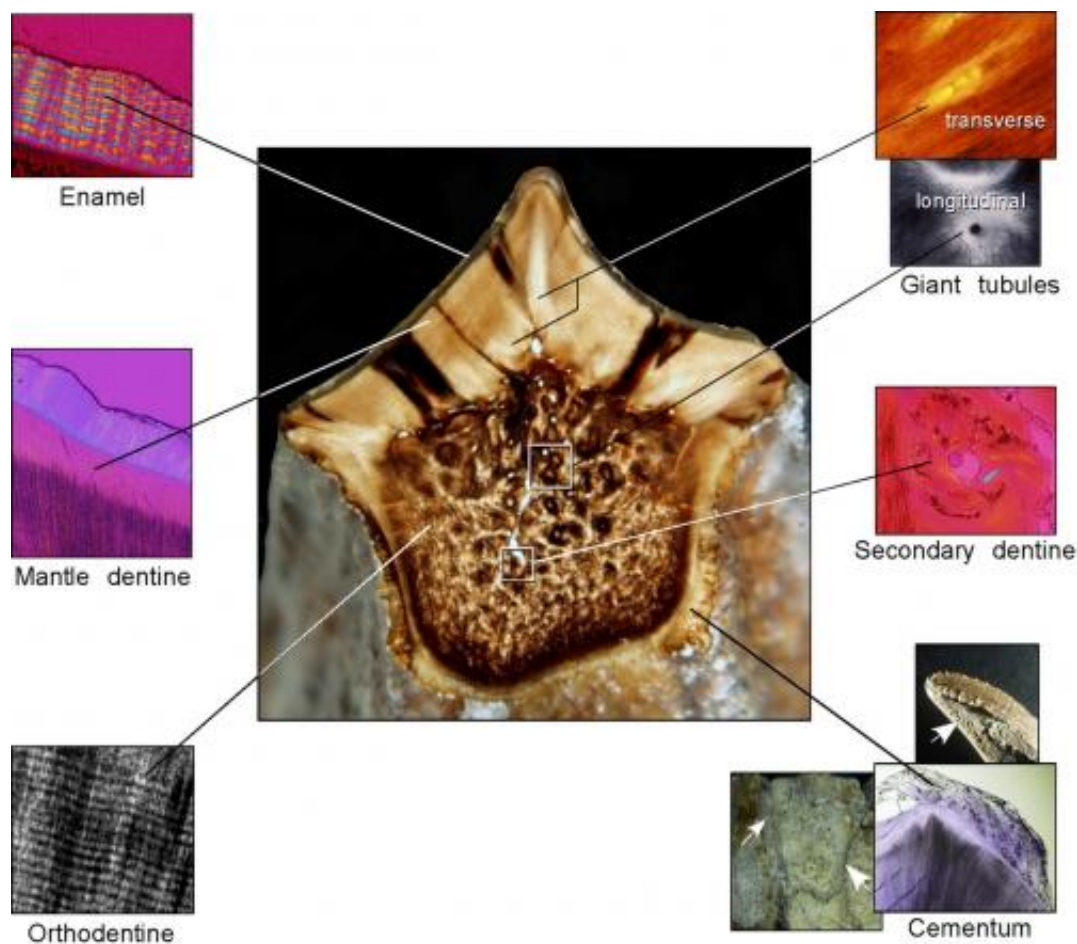


# Fossilized teeth—Duck-bill dinosaurs had plant-pulverizing teeth more advanced than horses

October 4 2012



This cross-section of a duck-billed dinosaur tooth (*Edmontosaurus*) shows the remarkably complex architecture. Six main tissues compose the tooth, where most reptiles only have two (enamel and orthodentine). Like horse, bison, and elephant teeth, the myriad of tissues--each with their own unique wear attributes--allowed the teeth to self-wear with use to form complex grinding

surfaces. These dinosaurs possessed among the most sophisticated teeth known.  
Credit: G. M. Erickson/Florida State University

A team of paleontologists and engineers has found that duck-billed dinosaurs had an amazing capacity to chew tough and abrasive plants with grinding teeth more complex than those of cows, horses, and other well-known modern grazers. Their study, which is published today in the journal *Science*, is the first to recover material properties from fossilized teeth.

Duck-bill dinosaurs, also known as hadrosaurids, were the dominant plant-eaters in what are now Europe, North America, and Asia during the Late Cretaceous about 85 million years ago. With broad jaws bearing as many as 1,400 [teeth](#), hadrosaurids were previously thought to have chewing surfaces similar to other reptiles, which have teeth comprised of just two tissues—enamel, a hard hypermineralized material, and orthodontine, a soft bonelike tissue. But [paleontologists](#) who study the [fossilized teeth](#) of these animals in detail suspected that they were not that simple.

"We thought for a long time that there was more going on because you could just look at the surface of the tooth and see advanced topography, which suggests that there are many different tissues present," said Mark Norell, chair of the [American Museum of Natural History](#)'s Division of [Paleontology](#) and an author on the paper.



This photo shows the horse-like chewing surface in a hadrosaurid dental battery. The crests and basins form through differential wear of the dental tissues. Credit: G. M. Erickson/Florida State University

To investigate the dinosaurs' dental structure and properties in depth, Norell worked with lead author Gregory Erickson, a biology professor at Florida State University, and a team of engineers on a series of novel experiments. Erickson sectioned the fossilized teeth and made microscope slides from them. These revealed that hadrosaurids actually had six different types of dental tissues—four more than reptiles and two more than expert [mammal](#) grinders like horses, cows, and elephants. Using a technique called nanoindentation, in which a diamond-tipped probe is indented and/or drawn across the fossilized teeth to mimic the grinding of abrasive food, the researchers determined the differential hardness and wear rates of the dental tissues.

Erickson, who describes hadrosaurid dinosaurs as "walking pulp mills," said, "We were stunned to find that the mechanical properties of the teeth were preserved after 70 million years of fossilization." He went on to comment that "if you put these teeth back into a living dinosaur they would function perfectly."

In addition to the four dental tissues found in mammals—enamel, orthodontine, secondary dentine that helps prevent cavities, and coronal cementum that supports the teeth's crests—the hadrosaurid teeth include giant tubules and a thick mantle dentine. These extra tissues are thought to provide additional prevention against abscesses. Also unlike mammalian teeth, the dental tissue distribution in hadrosaurids greatly varied in each tooth.

Together, these characteristics suggest that hadrosaurids evolved the most advanced grinding capacity known in vertebrate animals, which might have led to their extensive diversification.

"Duck-bills' advanced tissue modification appears to have allowed them to radiate into specialized ecological niches where they ate extremely tough plants like fern, horsetail, and ground cover that were not as easy for dinosaurs with shearing teeth to eat," Norell said. "Their complex dentition could have played a major role in keeping them on the planet for nearly 35 million years."

In addition, the findings provide strong evidence that dental wear properties are preserved in fossil teeth—an idea that was once questioned and overruled in this study with comparative tests on teeth from modern and fossilized horses and bison. This opens the door for studies on the dental biomechanics of fossils from wide-ranging groups of animals to better understand evolutionary modifications in diets.

**More information:** G. M. Erickson, B. A. Krick, M. Hamilton, G. R.

Bourne, M. A. Norell, E. Lilleodden, W. G. Sawyer, "Complex Dental Structure and Wear Biomechanics in Hadrosaurid Dinosaurs," *Science* (2012).

Provided by American Museum of Natural History

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