

# What caused this megatooth shark's massive toothache?

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Artistic reconstruction of *Otodus megalodon* feeding upon an ancient swordfish ~11 - 3.7 million years ago. A puncture injury to the tooth gum such as this may have caused gemination of the developing tooth buds. Credit: Jorge Gonzalez

Did the world's largest prehistoric shark need an orthodontist, or did it just have a bad lunch?

Researchers from North Carolina State University and the North Carolina Museum of Natural Sciences examined a deformed tooth from an *Otodus megalodon* shark in a search for the root cause: was it developmental, or related to feeding? The work could give paleontologists more insight into the developmental processes associated with tooth injury in ancient sharks, as well as feeding behavior.

At issue is an abnormality referred to as double tooth pathology, in which a single tooth appears "split." There are several possible causes: during tooth development two tooth buds can fuse into one or one tooth bud can split into two (a process called gemination). Gemination and fusion can be caused by disease, genetics or physical injury to the tooth bud.

"We don't have a lot of data on double tooth pathologies in ancient shark species," says Harrison Miller, former NC State undergraduate student and corresponding author of a paper describing the work. "So this was an opportunity to fill in those gaps—and perhaps learn more about the sharks in the process."

The researchers examined three abnormal teeth: one 4-inch tooth from *O. megalodon*, an [apex predator](#) the size of a school bus that ruled the seas in the Miocene and early Pliocene periods (from 11 to 3.7 million years ago); and two from *Carcharhinus leucas*, a much smaller bull shark species that lived during the same period and still roams the seas today.



Normal versus deformed *O. megalodon* and *C. leucas* teeth. Credit: Matthew Zeher

All three oddly-shaped teeth displayed a form of double tooth pathology. The researchers compared the teeth to normal teeth from both species and performed nano-CT imaging of the deformed teeth so that they could examine what was going on inside.

While the pathological teeth did have more internal canals than normal teeth—confirming either the incomplete splitting or joining of two teeth during development—the researchers were unable to definitively establish a developmental cause.

"Part of the difficulty was in applying terminology from work in humans

and other mammals to sharks," says Haviv Avrahami, NC State doctoral student and paper co-author.

"Sharks have cartilaginous skeletons, not boney skeletons, so preservation of their jaws is rare in the [fossil record](#), and usually, we only find the individual isolated teeth. Additionally, sharks have different mechanisms for [tooth development](#)—they have continuous tooth replacement, so you can't look at what is happening in the rest of the jaw to rule out fusion or gemination."

Given what the researchers know about this kind of pathology in modern shark teeth, however, they lean toward feeding-related injury as a more probable cause.

"With *O. megalodon* in particular, the current understanding is that they fed mostly on whales," Avrahami says. "But we know that tooth deformities in modern sharks can be caused by something sharp piercing the conveyor belt of developing [teeth](#) inside the mouth. Based on what we see in modern sharks, the injury was most likely caused by chomping down on a spiny fish or taking a nasty stab from a stingray barb."

"We also know that *O. megalodon* had nesting grounds around Panama, and that relatives of modern stingray species also inhabited that area," Harrison says. "And these spines can get very thick. So a tooth injury of this type could indicate that *O. megalodon* was more of a generalist predator—and that this *O. megalodon* in particular just had a bad day."

Lindsay Zanno, head of paleontology at the N.C. Museum of Natural Sciences, associate research professor at NC State and co-author of the research, agrees.

"When we think of predator-prey encounters, we tend to reserve our sympathy for the prey, but the life of a predator, even a gigantic

megatooth shark, was no cakewalk either."

The work appears in *PeerJ*, and was made possible by Mark Kostich's donation of the pathological *O. megalodon* [tooth](#) (NCSM 33639) to the Paleontological Collections of the N.C. Museum of Natural Sciences.

"We're incredibly grateful to Mark for gifting this specimen to the museum so we could learn more about these ancient animals," Zanno says. "So many important fossils are hidden away in private collections, where they are unable to shed new light on our wondrous world."

**More information:** Harrison S. Miller et al, Dental pathologies in lamniform and carcharhiniform sharks with comments on the classification and homology of double tooth pathologies in vertebrates, *PeerJ* (2022). [DOI: 10.7717/peerj.12775](https://doi.org/10.7717/peerj.12775)

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