

# **Predatory dinosaurs such as T. rex sported lizard-like lips, suggests study**

March 30 2023

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Tyrannosaurus rex bellowing with its mouth shut, like a vocalizing alligator. With its mouth closed, all of the enormous teeth of T. rex would be invisible behind its lips. Credit: Mark Witton

A new study suggests that predatory dinosaurs, such as Tyrannosaurus rex, did not have permanently exposed teeth as depicted in films such as Jurassic Park, but instead had scaly, lizard-like lips covering and sealing their mouths.

Researchers and artists have debated whether theropod dinosaurs, the group of two-legged dinosaurs that includes carnivores and top predators like T. rex and Velociraptor, as well as birds, had lipless mouths where perpetually visible upper [teeth](#) hung over their lower jaws, similar to the mouth of a crocodile.

However, an international team of researchers challenge some of the best-known depictions, and say these dinosaurs had lips similar to those of lizards and their relative, the tuatara—a rare reptile found only in New Zealand, which are the last survivors of an order of reptiles that thrived in the age of the dinosaurs.

In the most detailed study of this issue yet, the researchers examined the [tooth structure](#), wear patterns and jaw morphology of lipped and lipless reptile groups and found that theropod mouth anatomy and functionality resembles that of lizards more than crocodiles. This implies lizard-like oral tissues, including scaly lips covering their teeth.

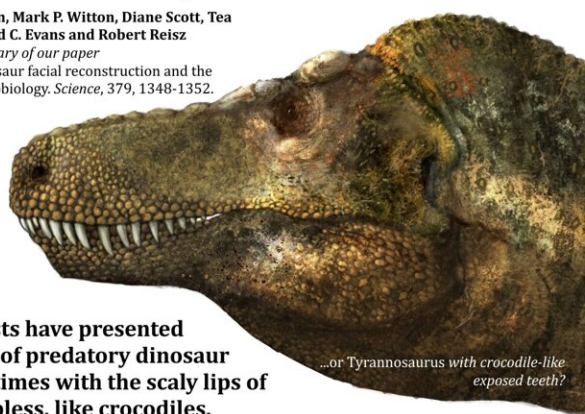
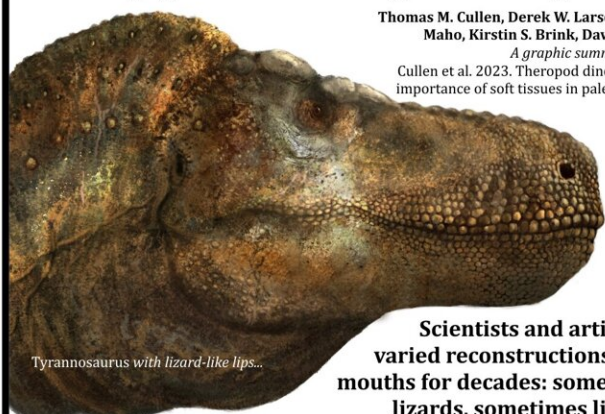


# Lipped or lipless predatory dinosaurs?

Thomas M. Cullen, Derek W. Larson, Mark P. Witton, Diane Scott, Tea Maho, Kirstin S. Brink, David C. Evans and Robert Reisz

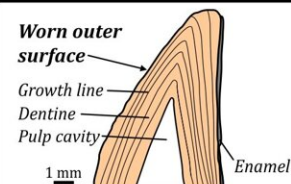
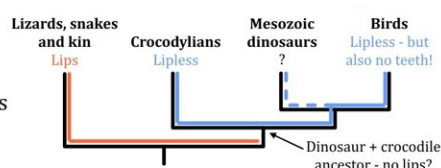
A graphic summary of our paper

Cullen et al. 2023. Theropod dinosaur facial reconstruction and the importance of soft tissues in paleobiology. *Science*, 379, 1348-1352.



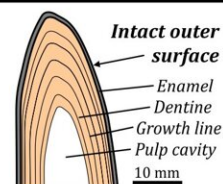
Scientists and artists have presented varied reconstructions of predatory dinosaur mouths for decades: sometimes with the scaly lips of lizards, sometimes lipless, like crocodiles.

Lips are absent in crocodiles, which are cousins of extinct dinosaurs, as well as living dinosaurs, the birds. Some researchers have therefore assumed that dinosaurs also had lipless mouths and exposed teeth. But dinosaur tooth and jaw anatomy is quite different from that of crocodiles and, in a new paper, we compare these in several studies to clarify the configuration of predatory dinosaur mouth tissues.

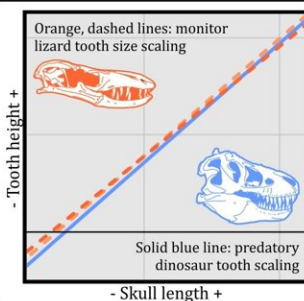


Cross-section through crocodile (lipless) tooth tip

**1. TOOTH DAMAGE AND WEAR**  
The teeth of lipless animals are characterised by high amounts of wear and abrasion on their exposed surfaces. Carnivorous dinosaurs do not show this high level of damage on their outer edge, implying that their teeth were not exposed.



Cross-section through predatory dinosaur tooth tip



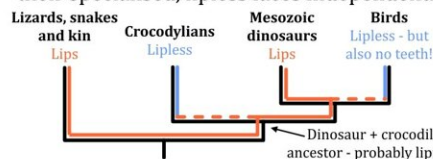
**2. TOOTH SIZE**  
Predatory dinosaur teeth are no larger, relative to skull size, than those of modern lizards, implying they are not too big to cover with lips.



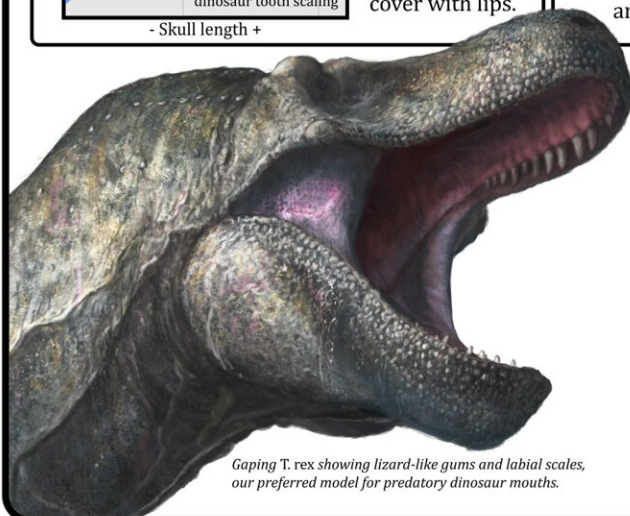
## 3. JAW MORPHOLOGY

Perforations around the jaws, which supply sensory pathways and blood vessels to the gums and tissues around the mouth, are more lizard-like in dinosaurs than crocodile-like.

We conclude that predatory dinosaur tooth and jaw morphology is more consistent with a lipped configuration, and that birds and crocodiles evolved their specialised, lipless faces independently.



We further suggest that lizards and their relatives, which possess deep gum tissues as well as scaly lips, are the best modern analogue for predatory dinosaur mouth anatomy. Many of our most iconic dinosaur reconstructions may warrant revision!



A one-sheet summary of the main investigations and conclusions of the study.  
Credit: Mark Witton

These lips were probably not muscular, like they are in mammals. Most reptile lips cover their teeth but cannot be moved independently—they cannot be curled back into a snarl, or make other sorts of movements we associate with lips in humans or other mammals.

Study co-author Derek Larson, Collections Manager and Researcher in Paleontology at the Royal BC Museum in Canada, said, "Paleontologists often like to compare [extinct animals](#) to their closest living relatives, but in the case of dinosaurs, their closest relatives have been evolutionarily distinct for hundreds of millions of years and today are incredibly specialized.

"It's quite remarkable how similar theropod teeth are to monitor lizards. From the smallest dwarf monitor to the Komodo dragon, the teeth function in much the same way. So, monitors can be compared quite favorably with extinct animals like [theropod dinosaurs](#) based on this similarity of function, even though they are not closely related."

Co-author Dr. Mark Witton from the University of Portsmouth said, "Dinosaur artists have gone back and forth on lips since we started restoring dinosaurs during the 19th century, but lipless dinosaurs became more prominent in the 1980s and 1990s. They were then deeply rooted in popular culture through films and documentaries—Jurassic Park and its sequels, Walking with Dinosaurs and so on.



A half-grown Tyrannosaurus, sporting a full set of lips, runs down Struthiomimus, a beaked ostrich dinosaur. Credit: Mark Witton

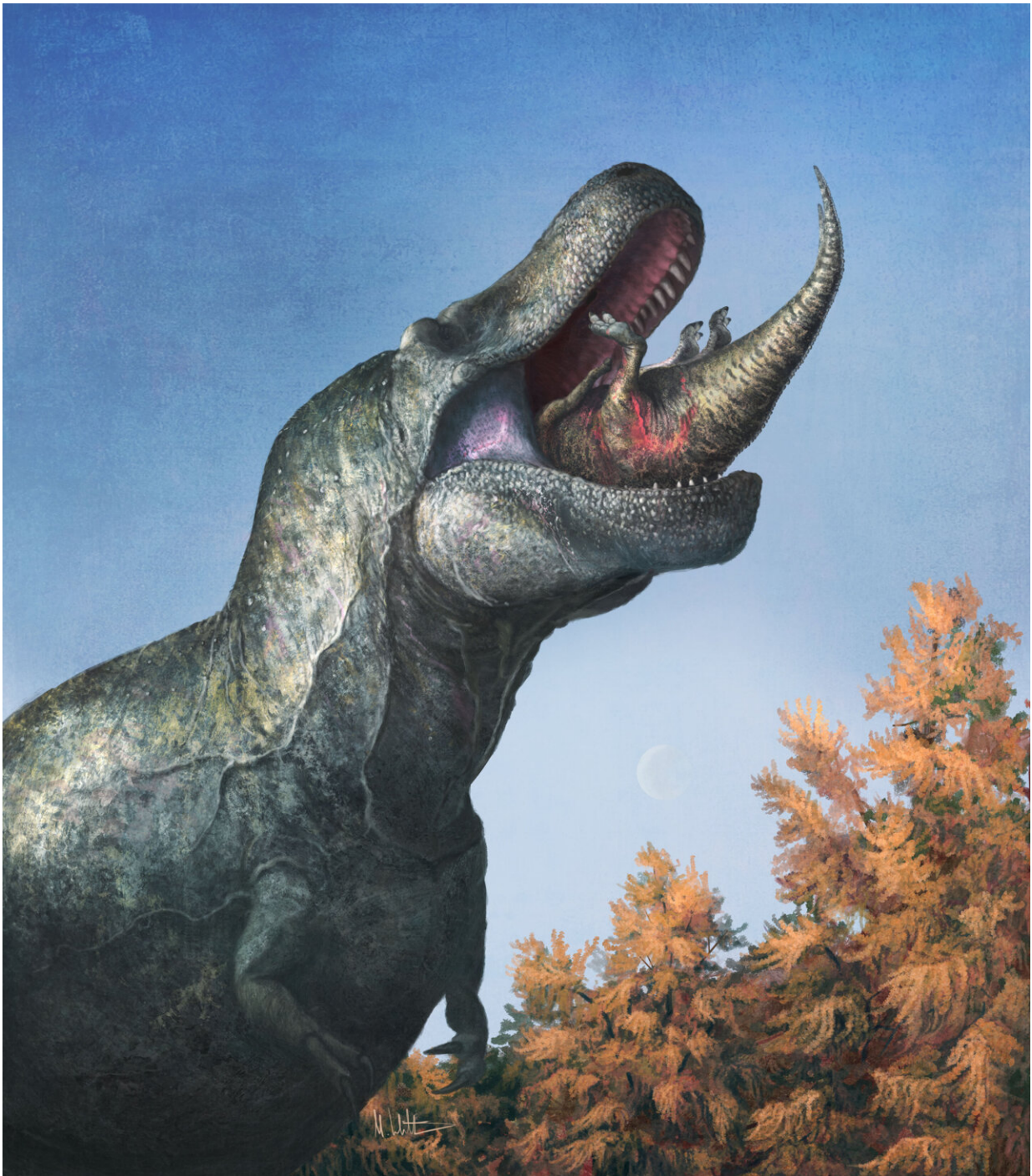
"Curiously, there was never a dedicated study or discovery instigating this change and, to a large extent, it probably reflected preference for a new, ferocious-looking aesthetic rather than a shift in scientific thinking. We're upending this popular depiction by covering their teeth with lizard-like lips. This means a lot of our favorite dinosaur depictions are incorrect, including the iconic Jurassic Park T. rex."

The results, published in the journal *Science*, found that tooth wear in lipless animals was markedly different from that seen in carnivorous dinosaurs and that dinosaur teeth were no larger, relative to skull size, than those of modern lizards, implying they were not too big to cover with lips.

Also, the distribution of small holes around the jaws, which supply nerves and blood to the gums and tissues around the mouth, were more lizard-like in dinosaurs than crocodile-like. Furthermore, modeling mouth closure of lipless theropod jaws showed that the lower jaw either



had to crush jaw-supporting bones or disarticulate the jaw joint to seal the mouth.



A juvenile Edmontosaurus disappears into the enormous, lipped mouth of Tyrannosaurus. Credit: Mark Witton

"As any dentist will tell you, saliva is important for maintaining the health of your teeth. Teeth that are not covered by lips risk drying out and can be subject to more damage during feeding or fighting, as we see in crocodiles, but not in dinosaurs," said co-author Kirstin Brink, Assistant Professor of Paleontology at the University of Manitoba.

She added, "Dinosaur teeth have very thin enamel and mammal teeth have thick enamel (with some exceptions). Crocodile enamel is a bit thicker than dinosaur enamel, but not as thick as mammalian enamel. There are some mammal groups that do have exposed enamel, but their enamel is modified to withstand exposure."

Thomas Cullen, Assistant Professor of Paleobiology at Auburn University and study lead author, said, "Although it's been argued in the past that the teeth of [predatory dinosaurs](#) might be too big to be covered by lips, our study shows that, in actuality, their teeth were not atypically large. Even the giant teeth of tyrannosaurs are proportionally similar in size to those of living predatory lizards when compared for skull size, rejecting the idea that their teeth were too big to cover with lips."

The results provide new insights into how we reconstruct the soft-tissues and appearance of dinosaurs and other extinct species. This can give crucial information on how they fed, how they maintained their dental health, and the broader patterns of their evolution and ecology.





T. rex skull and head reconstructions. Credit: Mark Witton

Dr. Witton said, "Some take the view that we're clueless about the appearance of dinosaurs beyond basic features like the number of fingers and toes. But our study, and others like it, show that we have an increasingly good handle on many aspects of dinosaur appearance. Far from being clueless, we're now at a point where we can say 'oh, that doesn't have lips? Or a certain type of scale or feather?' Then that's as realistic a depiction of that species as a tiger without stripes."

The researchers point out that their study doesn't say that no extinct animals had exposed teeth—some, like saber-toothed carnivorous mammals, or marine reptiles and flying reptiles with extremely long, interlocking teeth, almost certainly did.

**More information:** Thomas M. Cullen et al, Theropod dinosaur facial reconstruction and the importance of soft tissues in paleobiology, *Science* (2023). [DOI: 10.1126/science.abo7877](https://doi.org/10.1126/science.abo7877).  
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Provided by University of Portsmouth

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