

Read My Lips

The Enigmatic Smile of *Tyrannosaurus rex*

by Preston Knowles

Thanks to recent discoveries and changes in scientists' understanding of the lifestyle and appearance of dinosaurs, paleontologists are able to piece together the facial structure and appearance of many species, including *Tyrannosaurus rex*. Many will remember the chilling scene in the first installment of the *Jurassic Park* series in which *T. rex* escapes the paddock and her teeth flash like bayonets in the ominous lighting. In the thirty or so years since that film appeared, vertebrate paleontology has realized the inaccuracy of showing the long teeth of *T. rex* exposed even when its mouth was fully closed.

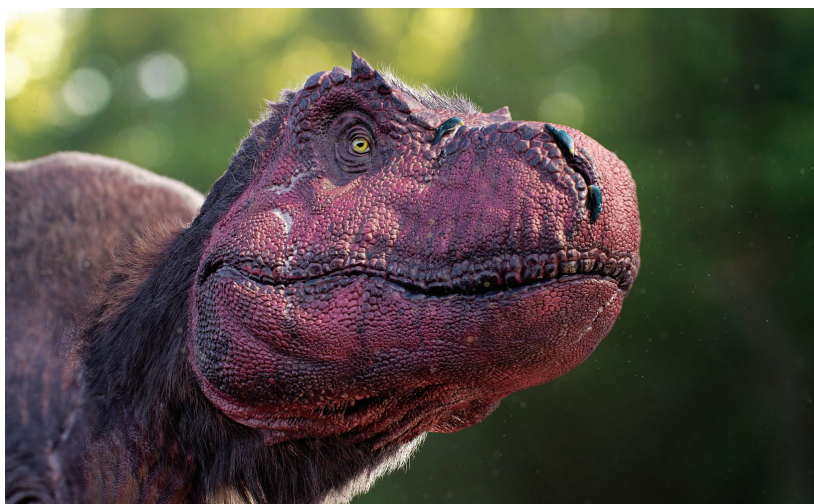
The teeth of living reptiles are an important analogy for the structure of *T. rex* teeth. Many reptilian species alive today have some sort of covering (lips or analogous tissue) to protect their teeth, although alligators, crocodiles, gavials, and related species are an exception.

Animals with teeth need lips or some other source of constant hydration so that the crystalline structure of calcium hydroxyapatite, the minerals that makes up bones and teeth, will not dry out and shrink, causing cracks. Because *T. rex* constantly used its immense jaws for bone-breaking bites, cracks from dehydration would have led to regular tooth breakage. Evidence of tooth breakage in fossil *T. rex* teeth is known, but it would be much more common if *T. rex* had no oral covering. Crocodiles and their relatives can get along without lips because of their aquatic lifestyles: their exposed, protruding teeth are constantly hydrated in water. Because of that, these animals can maintain a high bite force without danger of shattering their teeth.

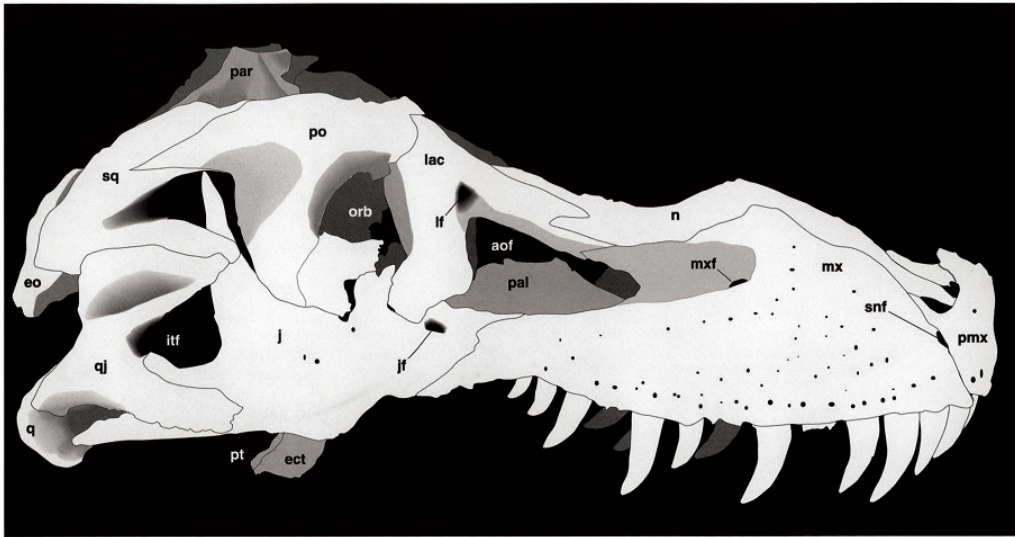
Another piece of evidence to suggest that *T. rex* had lips concerns the way teeth lock together when the mouth is closed. When a crocodile or alligator closes its mouth, the teeth interlock as the upper and lower jaws meet. In the case of *T. rex*, conversely, the lower jaw is

narrower and fits inside the upper jaw. With its mouth closed—as even extremely “toothy” reconstructions of *T. rex* show—none of the teeth in the lower jaw are visible. This suggests that a lip might have covered the upper teeth, protecting them, while the teeth of the lower jaw were safely enclosed within the mouth.

The biggest piece of evidence to support *T. rex* having some sort of extra-oral covering is the presence of foramina in the jaw bone. Foramina are openings within a region of the skull through which nerves, blood vessels,



Top: The “classic” *T. rex* pose with upper teeth exposed and extending over the top edge of the mandible. Bottom: A *T. rex* with an extra-oral covering—lips, if you like—that keeps both rows of teeth covered and hydrated.



A schematic drawing of the skull of "Sue" the *T. rex*. The foramina are the black dots, representing holes in the bone, visible all along the upper jaw (mx or maxilla in the diagram) and the premaxilla (pmx). Taken from Brochu, C. A. (2003). *Osteology of Tyrannosaurus rex: Insights from a Nearly Complete Skeleton and High-Resolution Computed Tomographic Analysis of the Skull*. *Journal of Vertebrate Paleontology*, 22, 1-138; from Witton (2018).

and other structures pass. Although collectively these are known as cranial foramina, the structures of interest here are those along the edges of the jaw bones, called labial foramina.

These small holes, easily seen without the use of a magnifying glass or a microscope, are present in the jaws of most theropod animals. A 2009 Master's Thesis by Ashley Morhardt examined whether a correlation existed between the number of foramina and the presence or absence of extra-oral tissues in a wide variety of vertebrate organisms. For instance, Morhardt compared foramina counts in more than 200 species, from pythons, boas, and vipers to dozens of species of living lizards and monitors, to a hundred different dinosaurs, to birds of all kinds, to raccoons and mongoose, and even to domestic dogs and cats. Comparisons of those average counts in the premaxilla, maxilla, and dentary (the front section of the lower jaw or mandible) showed that those with counts below 100, including both Ornithischian and Saurischian dinosaurs, indicated the presence of lips or some other extra-oral covering.

Morhardt's conclusion, then, was that the correlation she hypothesized did exist. She wrote, "When compared to the rest of the sample, dinosaurs included in this study fall within the range of organisms that have extra-oral coverings ... support[ing] the hypothesis that foramina density is correlated to some degree with extra-oral structures."

British paleontologist Mark Witton, commenting on Morhardt's work, noted that "although tyrannosaurids [reported by Morhardt] have elevated numbers of jaw foramina compared to other dinosaurs, their numbers

are, on average, significantly lower than those of crocodylians.... No tyrannosaurid jaw bone ... exceeds 81 foramina, which is high for a dinosaur, but still short of the crocodylian average, and well below the 1000+ figure reported for some croc jaws (Witton, 2018).

As British paleontology YouTuber Ben G. Thomas pointed out in an informative video from 2020, the snarling, bloody-toothed "meatosaurus" is, to some extent, a modern obsession. Dinosaurs

haven't always been portrayed that way. One example is paleoartist Charles R. Knight's *T. rex* (below), dating probably to the 1920s, which shows a closed mouth with lips clearly covering the teeth.

Still, Thomas noted, the pervasiveness of images of gaping, terror-inspiring jaws has, at least in part, played a role in one common objection to the "lip theory": the idea that *T. rex* teeth



were just “too large” to have been covered by lips. More likely, Thomas explained, was “tooth slippage”—the sliding of teeth slightly out of their sockets after death—which causes *T. rex* teeth displayed in museum specimens (and, consequently, in reconstructions) to appear larger and more exposed than they likely were.

The closest living analogy to the kind of immobile oral lip covering that *T. rex* may have had would probably be the bearded dragon of Australia or the various species of iguana found in many parts of the world. Their extra-oral coverings are immobile but cover the teeth when the mouth is closed and keep them moisturized enough to prevent dehydration or crystallization. Interestingly, their teeth aren’t always visible even when their mouths are open. Using living water monitors as an example, Thomas also pointed out in his video that soft tissues in the mouth can cover a surprising amount of tooth and speculates that such may also have been the case with tyrannosaurs and other meat-eating theropods.

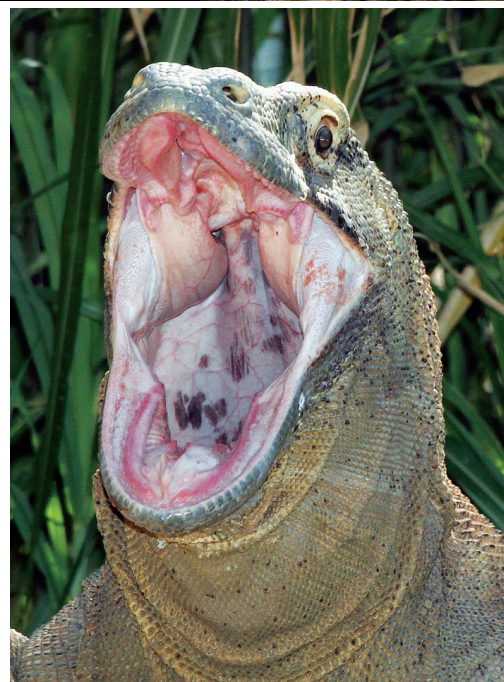
An arrangement like that would have been ideal for *T. rex*: an inflexible covering that maintained hydration around the dentition, allowing the “king tyrant lizard” to keep its teeth healthy and its bite force formidable.

Works Cited

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Above, top: A blue iguana and, middle, a bearded lizard, both with immobile lips. Bottom: A Komodo dragon, a close relative of the water monitor, opens its mouth wide but shows no teeth (© Paddy Ryan). At left: For comparison, the skull and dentition of a Komodo dragon (© Danadi Sutjiyanto).