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A paleontological outlook on the *Super Mario Bros.* movie

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Among the many unique choices made while making the 1993 movie *Super Mario Bros*. was the large focus on dinosaurs. Much of the movie takes place in Dinohattan, an alternate New York in a universe where humans evolved from dinosaurs instead of mammals. This was undoubtedly inspired by various reptilian species within the Mario games. That dinosaurs were extremely popular in the 90's certainly helped. New discoveries from the Dinosaur Renaissance of the 70's and 80's inspired new dinosaur media such as T*he Land Before Time*, *Jurassic Park*, and of course, *Super Mario Bros*. *Jurassic Park* in particular ushered in a huge wave of dinosaur media, with many since bearing at least one reference to the film. *Super Mario Bros*. was the last major piece of dinosaur media to be released before the *Jurassic Park* wave, predating that film's release by only a few weeks.

NEW YORK AND THE END OF THE CRETACEOUS

The movie's infamous introduction details the extinction of the non-avian dinosaurs via meteorite impact. At the time we knew a meteorite was to blame, thanks to iridium. Iridium is an element very rare on

Figure 1. Brooklyn 65 million years ago, according to *Super Mario Bros*. It didn't look like this in real life – at the time, the area that is now New York City was at the bottom of the Atlantic Ocean.

earth, but common in asteroids, and there's a global layer of iridium in the rock record right at the boundary between the Cretaceous and the Paleogene (Alvarez et al., 1980). This even got a shout-out in *Super Mario Bros*. In the early 90's, the location of the impact site wasn't certain – but we would soon find out it wasn't Brooklyn (Fig. 1). The Chicxulub crater, buried underneath Mexico's Yucatan Peninsula, has been dated to just under 66 million years ago – right at the K-Pg boundary (Hildebrand et al., 1991). This crater is estimated to be 150 km wide and 20 km deep, created by an impactor roughly the size of Mount Everest. It would have obliterated everything within the vicinity in a frction of a second, leaving nothing behind to fossilize.

The notion of digging up tyrannosaurs in Brooklyn is also doubtful. Long Island is very recent geologically, being formed by glaciers during the last Ice Age – the same glaciers that ground away most of New York state's Cretaceous rocks (Charles Marshall, pers. comm.). But we can make inferences about what lived there based on fossils found in nearby states like New Jersey. During the Cretaceous, there was an inland seaway that split North America into two continents, Laurentia in the west and Appalachia in the east. The two continents had different faunas – Appalachia didn't have any of the famous Late Cretaceous dinosaurs Laurentia did. At the end of the Cretaceous, New York state would have been on the coast of a much narrower Atlantic Ocean, and the city was underwater.

Dinosaurs that lived on the eastern seaboard included ostrich-like ornithomimids (Brownstein, 2017), armored nodosaurids (Burns, 2016), duckbilled hadrosaurs (Prieto-Marquez et al., 2006), and *Dryptosaurus*. *Dryptosaurus* (Fig. 2) was a relative of *Tyrannosaurus*, around half the size but leaner and with larger arms (Brusatte et al., 2011). If *T. rex* was a tiger, *Dryptosaurus* would have been a leopard. In the skies flew early seabirds (Weishampel et al., 2004), and out at sea lived a variety of marine reptiles, such as sea turtles and plesiosaurs. The most famous marine reptiles, however, would be mosasaurs – large ocean-going lizards whose limbs had evolved into dolphin-like flippers. These ranged in size from the three-meter long *Halisaurus* to the fifteen-meter long *Mosasaurus* (Gallagher, 2005). Although the fossils Daisy finds may not line up with real life, Anthony Scapelli's interference with the dig is unnervingly close to reality, as many field paleontologists will tell you.

Figure 2. A life-sized model of *Dryptosaurus*, built by Tyler Keillor and on display at the Dunn Museum in Libertyville, Illinois, USA.

DINOSAURS

Jurassic Park closely followed the science of the time, bringing an updated image of dinosaurs to the public. Heavily inspired by the Dinosaur Renaissance, and the growing body of evidence that birds are a clade of dinosaurs, that movie's dinosaurs were energetic, warm-blooded, awe-inspiring, dangerous, and in some cases intelligent. As the previous public perception of dinosaurs was that of slow, lumbering, cold-blooded evolutionary failures, this brought a paradigm shift in popular culture, and a renewed interest in the science of paleontology (Liptak, 2018). *Super Mario Bros*. was not part of this paradigm shift. It's clear the filmmakers were still in the mindset that dinosaurs were cold-blooded and reptilian. The Goombas (Fig. 3) – de-evolved Dinohattanites – are dumb and lumbering. They resemble the synapsid *Cotylorhynchus* (Fig. 4) more than any actual dinosaur. Yoshi (Fig. 3) is a little more active, but he's still highly caricaturized and clearly a relic from the 80's, paleontologically speaking. Not to mention, many dinosaurs are now known to have had feathers alongside or instead of scales (*e.g.*, Godefroit et al., 2014), and it's likely that ancestrally, all dinosaurs had feathers of some sort, and only larger forms lost theirs (Yang et al., 2019).

Figure 3. Some of the dinosaurian residents of Dinohattan: Daisy, a normal dinosaur-descended relative of Dinohattan (upper left); Yoshi, a more dinosaur-y dinosaur (upper right); and a Goomba, a de-evolved Dinohattanite (below). None of these closely resemble real dinosaurs, and suffice it to say, they don't resemble their video game counterparts either.

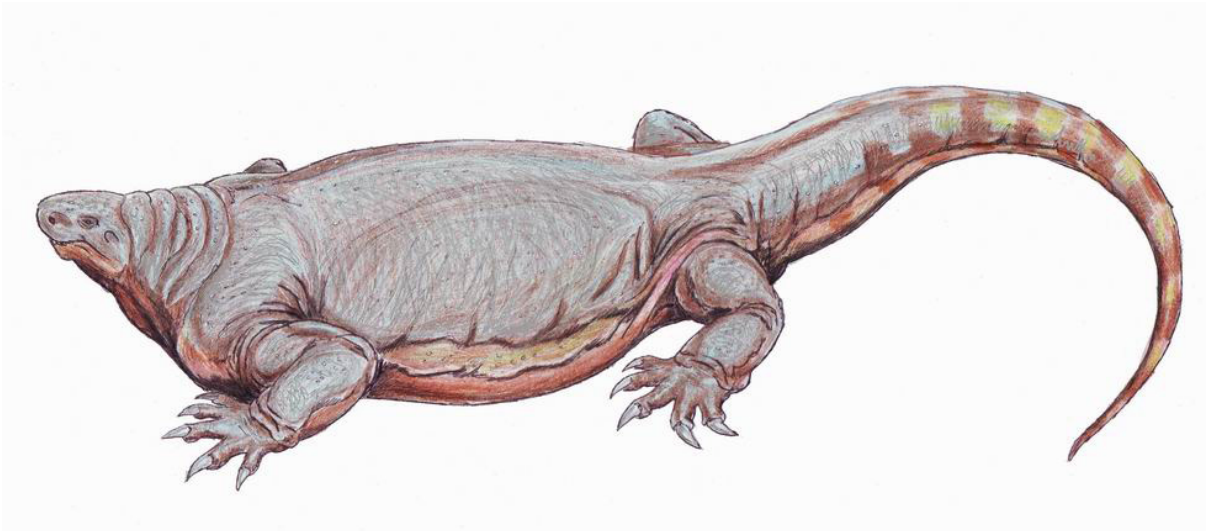

Figure 4. *Cotylorhynchus.* Despite how it may look, this is a very early relative of mammals. By sheer coincidence, it happens to resemble *Super Mario Bros.*' Goombas. Restoration by Dmitry Bogdanov.

President Koopa – who proudly brags about being descended from *Tyrannosaurus rex* – shows reptilian features such as a long, forked, flicking tongue and (sometimes) slit-like eyes. Both of these are common in living squamates (lizards and snakes), but not dinosaurs. Squamates that flick their tongues use it to gather scent particles, which is then processed by an organ in the roof of the mouth, called the Jacobson's organ. No dinosaurs had this organ (Naish, 2016). Many dinosaurs had immobile tongues, like alligators, or non-forked birdlike tongues (Li et al., 2018). The way a vertical pupil scatters light is good for predators that have their heads low to the ground – up to about the height of a cat's head (Banks et al., 2015). The vast majority of dinosaurs probably had round pupils like those of birds.

EVOLUTION AND DE-EVOLUTION

Super Mario Bros. was not the first nor the last project to speculate on what might have happened had the dinosaurs not all been destroyed. Perhaps the two cornerstone works on this topic are Dougal Dixon's *The New Dinosaurs* and the collaborative online *Speculative Dinosaur Project*, both of which detail creatures that could have evolved 65 million years after an asteroid impact that never happened. Indeed, *Super Mario Bros.* wasn't even the first to feature dinosaurs evolving into intelligent (…to a degree) life. The first to pose the question was none other than Carl Sagan, inspired by then-new research on the brain size of a family of dinosaurs called troodontids (Sagan, 1977). These dinosaurs, including the likes of *Stenonychosaurus* (Fig. 5) and *Saurornithoides*, were small-to-medium-sized omnivores with a very large brain relative to body size. In these ways they're a lot like the ancestors of humans, and thus are good candidate for evolving into sapient beings. Paleontologist Dale Russell took this a step further in 1982, with the "dinosauroid" – a human-shaped descendant of *Stenonychosaurus* (Russell & Séguin, 1982). He even commissioned a life-sized model (Fig. 5), which looks a bit more like an alien than a dinosaur. The dinosauroid isn't human to the same degree as the residents of Dinohattan, but it may have provided some inspiration for the filmmakers.

The film's idea of evolution has also not exactly held up. "You may think of evolution as an upward process," muses President Koopa right before he de-evolves Toad into a Goomba. It isn't. Evolution isn't about levels, with "basic" life progressively evolving towards a more advanced endpoint. Dale Russell certainly thought it was, which is why the dinosauroid looks so human-like (Darren Naish, pers. comm.). But evolution isn't a constant progression towards a form that's intrinsically "more advanced". An

entire rundown of the theory of evolution is out of the scope of this paper, but in short, it is simply change over time (Darwin, 1859). This is often in response to environmental change, where features that help the organism better survive and reproduce are selected for (but sometimes things evolve solely because they help the organism reproduce, for example the tail of the peacock). If a certain set of features works, there may not be reason to change much. Fossil horseshoe crabs and lungfish dating to the Jurassic are effectively identical to those around today, for example.

Figure 5. Dale Russell's Dinosauroid statue, next to a contemporary reconstruction of *Stenonychosaurus*. Compare and contrast to the residents of Dinohattan.

The "linear" idea of evolution forms the basis of *Super Mario Bros.'* de-evolution. De-evolution isn't a thing. Evolution acts with no foreknowledge or back-knowledge. An organism can theoretically evolve to superficially resemble one of its ancestors, but the mechanism behind this is no different than it evolving into something that looks completely different. This is a principle called Dollo's Law – an organism can never return exactly to the evolutionary state its ancestors had (Gould, 1970). You can't de-evolve something to what it'd be like in the Cretaceous. And since evolution acts on populations, not individuals (Darwin, 1859), the notion of de-evolving someone in particular is impossible.

CONCLUSION

Between the movie's bombing among critics and audiences upon release and *Jurassic Park* being released a few weeks later, *Super Mario Bros*. never got an opportunity to leave a mark upon dinosaur media. It does leave a legacy technologically, though: the digital visual effects techniques, many of which were invented for the film, have since become industry standards, and the Yoshi animatronics set a standard for later dinosaur movies to live up to (they even impressed the producers of *Jurassic Park*). *Super Mario Bros*. was also the beginning of John Leguizamo's inexplicable connection to prehistoric life – he would later lend his voice to the Ice Age franchise and the movie adaptation of *Walking with Dinosaurs* in 2013. And it left us with a few choice words of wisdom: trust the fungus.

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About the author

Henry Thomas is a paleontology student at the University of California, Berkeley. His main research interest is pterosaurs, which the *Super Mario Bros*. movie unfortunately lacks.