Dinosaur art evolves with new discoveries in paleontology

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Under soft museum lights, the massive skeleton of a *Tyrannosaurus rex* is easy to imagine fleshed out and alive, scimitar teeth glimmering. What did it look like in life? How did its face contort under the Montana sun some 66 million years ago? What color and texture was its body? Was it gauntly wrapped in scales, fluffy with feathers, or a mix of both?

Increasingly, paleontologists can offer answers to these questions, thanks to evidence of dinosaur soft tissues discovered in the last 30 years. Translating those discoveries into works that satisfy the public's imagination is the purview of paleoartists, the scientific illustrators who reconstruct prehistory in paintings, drawings, and sculptures in exhibit halls, books, magazines, and films.

Those creations necessarily require some artistic license, says freelancer Gabriel Ugueto, who's based in Miami, FL. As new discoveries offer artists a better sense of what their subjects looked like, the findings also constrain their creativity, he says, by leaving fewer details to the imagination.

Even so, he and other artists welcome new discoveries, as the field strives for accuracy. The challenge now is sifting through all this new information, including characteristics that are still up for debate, such as the extent of *T. rex's* feathers, to conjure new visions of the prehistoric world.

Paleoartists often have a general science background or formal artistic training, although career

Among the earliest examples of paleoart, this 1830 watercolor painting, called *Duria Antiquior* or "A more ancient Dorset," imagines England's South Coast populated by ichthyosaurs, plesiosaurs, and pterosaurs. Image credit: Wikimedia Commons/Sir Henry Thomas De la Beche.

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Fossil evidence of plesiosaur fat published in 2017 suggests a chunkier vision of those marine reptiles than previously thought. Image credit: Gabriel Ugueto.

paths vary. "There is no one way that people get into paleoart," says Mark Witton, a paleoartist and paleontologist at the University of Portsmouth in the United Kingdom, who recently wrote a paleoart handbook (1). Regardless of their backgrounds, professional paleoartists share a dedication to credibility and typically consult with paleontologists, or reference scientific articles and specimen photos, to ensure scientific accuracy—or at least defensibility if an animal's exact appearance remains open for debate.

Today's paleoart interpretations are informed by an unprecedented level of detail related to dinosaur skin, scales, fat, and feathers, thanks to hundreds of new fossil discoveries since the 1990s, Ugueto says. A 2017 study, for example, described the well-preserved remains of a plesiosaur, discovered in a quarry in northeastern Mexico. Plesiosaurs were marine reptiles with rounded bodies, short tails, and four flippers (2). Some had crocodile-like heads and long necks. This particular fossil lies on its back—a nearly complete skeleton surrounded by skin and thick, fatty, subdermal tissue, which looks like dark smudging surrounding the fossilized bones. It's among very few records of plesiosaur soft tissue ever found.

Responding to the discovery, Ugueto now draws his plesiosaurs with a layer of insulating fat, similar to that of modern marine mammals. Although the general public knows plesiosaurs from drawings reminiscent of the Loch Ness Monster, Ugueto says his thicker-necked and heavier-bodied depictions are well-received. "When you show people an animal that looks like an animal, there's a natural reaction of 'oh, yes, this makes sense,'" he says.

Plesiosaurs aren't the only prehistoric creatures depicted without much fat. Most dinosaurs, and even prehistoric mammals, are "shrink-wrapped," Ugueto says—the colloquial term for paleoart that squeezes the bones and muscles under a gaunt layer of skin. Shrink-wrapping is the conservative approach to imagining an entire animal based on fossil bones rather than speculating about soft tissue as well, says New Mexico-based freelance paleoartist Matt Celeskey; Ugueto believes that shrink-wrapping caught on simply because artists and paleontologists have been so focused on the form suggested by bones.

In any case, an artistic movement in the last decade is pushing back, arguing that modern animals look nothing like their skeletons. If paleoartists drew extant species based on their bones alone, "they'd be very grotesque, hyper-muscled things with all their teeth exposed," says Celeskey. Take roosters, for example. Illustrating them from their skeletons, he says, would overlook their crests, their wattles, the extent of spurs on their legs, and the iridescence of their feathers.

Menagerie of Methods

Artists gain fresh eyes on the past by studying newly unearthed fossils and by adopting new methods to revisit the fossils resting in museum drawers. Consider the famous dinosaur Archaeopteryx, a distant cousin of modern birds. Paleontologists found the first two putative Archaeopteryx fossils in Germany's Solnhofen limestone quarry around 1861. One was a single fossilized feather, and the other a skeleton with clearly preserved impressions of feathers surrounding it. Researchers wouldn't know the color of that plumage until 2012, when they analyzed the isolated fossilized wing feather, stored at the Museum of Natural History in Berlin, Germany, using a scanning electron microscope. They found the tiny, rod-shaped impressions and three-dimensional structures of melanosomes, organelles containing the pigment melanin within the feather's fibers. Based on the rod-shape and other characteristics of the melanosomes compared with those of modern birds, the authors concluded that the feather would have been black (3).

Another feathered dinosaur, unveiled in a study published in 2018, was iridescent (4), with arrays of flat and wide melanosomes stacked on top of each other in the feathers around its head and neck. Today's hummingbirds have the most similarly shaped arrays in their iridescent feathers, says study coauthor Julia Clarke, a paleontologist at the University of Texas at Austin.

Hence, artist renderings of the species, called *Caihong juji,* appropriately depict a shimmering head and neck. Artists wouldn't have the freedom to skip the iridescence on this animal. However, whether those feathers had a reddish, bluish, or greenish sheen is still up for artistic interpretation. The hue comes from the spacing of melanosome arrays in the feather, which was not preserved. "What tonalities that shiny color would have," Clarke says, "is artistic license."

Terrible Lizards

As paleontologists unearth new evidence, artists adapt. Artists' willingness to change with the field reflects a marriage of art and science over the last two centuries.

In her 2017 book *Paleoart: Visions of the Prehistoric Past*, New York-based journalist Zoë Lescaze tells the story of the first work of paleoart—a watercolor

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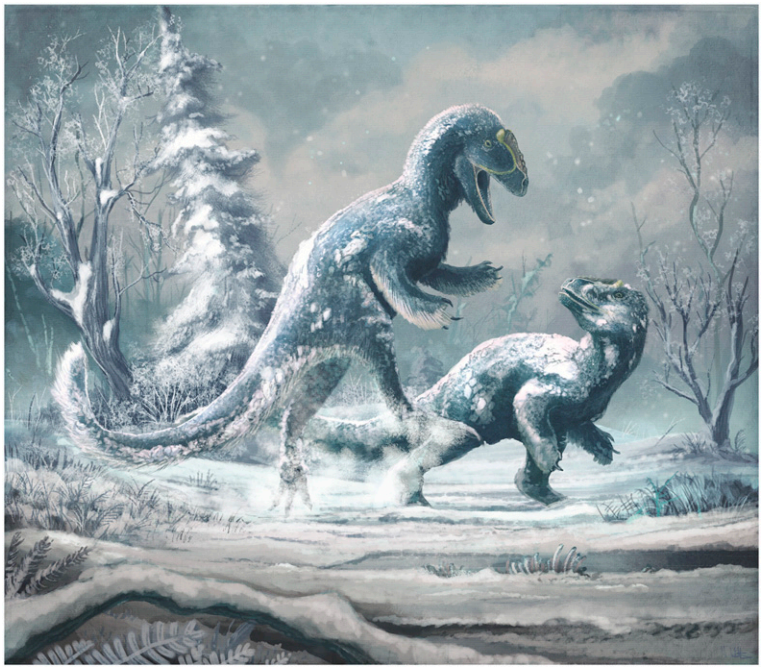

Created by paleoartist Mark Witton, this never-before-released image of a feathered cousin of the *T. rex* called *Yutyrannus* is an homage to legendary paleoartist Charles Knight. Because ancient cousins of *Tyrannosaurus* had feathers, some paleontologists and artists argue that *T. rex* would have had them as well. Image credit: Mark Witton.

painting of a prehistoric scene of England's southern coast populated by species known from local fossils, including marine and flying reptiles, and painted by English clergyman and geologist Sir Henry Thomas De la Beche, circa 1830 (5). "What's charming about that image," Lescaze says, "is he wasn't setting out to launch a genre. He was more or less trying to help a friend." De la Beche was raising money for Mary Anning, a prolific self-taught paleontologist, who discovered the first plesiosaur among other species, but received little credit for her discoveries because of her gender and class, according to Lescaze. To raise funds, De la Beche imagined his watercolor scene of the English coast full of species Anning had discovered. That painting "proved hugely influential," Lescaze says, "and sparked an interest among researchers in having their discoveries reanimated in this way."

The movement spread through Europe and across the Atlantic to the United States, infiltrating museums by the late 1800s. De la Beche and other early paleoartists strove for scientific accuracy. But there was just less evidence back then. New data about color and form gleaned from soft tissues, as well as details about animal movement based on bone stress tests, are "leaving less room for the artist's imagination," Lescaze says. Her book closes in the 1990s, when the field's aesthetic shifted away from fine art influences like impressionism, toward more realistic, almost photograph-like scientific illustrations.

A Great Debate

New data may limit artistic freedom, but they also open new possibilities. Take *T. rex,* for example: Two lines of potentially conflicting evidence hint at its appearance.

Fossils discovered in the last 20 years show that early relatives of *T. rex* had feathers "nose to tail," says paleontologist David Hone at Queen Mary University of London, England (6). Artists responded by illustrating *Tyrannosaurus* with a feathery coat. But then, three years ago, paleontologists found several small scraps of skin from across *T. rex's* body, with apparent scales instead of feathers (7).

Some artists had "an emotional response as well as a rational one," says Witton. For years, paleoartists had depicted *T. rex* with feathers, and Witton suspects that some people preferred that established style. Because the 2017 study only found a few small scaly skin patches, it didn't conclusively prove whether *T. rex* was entirely scaly or had some feathers, so artists still have some room for personal preference and interpretation.

Paleoartist Julius Csotonyi, based in British Columbia, Canada, faced the dilemma to depict *T. rex* with or without feathers recently, when the US Postal Service approached him to illustrate the "Nation's *T. rex,*" housed at the Smithsonian's National Museum of Natural History in Washington, DC, in a set of forever stamps released in August 2019. Csotonyi consulted with paleontologists and decided to take a middle path, illustrating a downy hatchling *Tyrannosaurus*, a juvenile with some feathers on its back, and an adult with scales and without feathers. He believes that there's insufficient data to determine whether *T. rex* had feathers or not, and he disagrees with some in the paleoart community who have taken a strong stance either way.

New evidence challenges artists to relearn the anatomy of animals they're already accustomed to reconstructing in a certain way, Witton says. Suddenly knowing the placement of feathers or color can be jarring.

But Witton doesn't believe that the new discoveries constrain paleoart. He says they feel more like new additions to his collection of knowledge, keeping him on his toes as he tries to stay current. At the core of paleoart "is a desire to recreate some sort of ancient truth," Witton says. "So it's a nice feeling when new data come along and you learn a little more, even about something familiar to you."

Updating illustrations of a familiar species can feel like seeing an old friend who's suddenly wearing glasses, he adds. It can be disconcerting. And yet, knowing what dinosaurs really looked like "is the end goal" Witton emphasizes. "This is what we should be moving toward."

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