DIGGING UP THE TRUTH

Myths about dinosaurs

Jeff J. Person

The beautiful thing about scientific knowledge is that it constantly changes. Ideas do not remain static, but evolve through time as we learn more about the world around us. What we thought to be true 100, 50, or even 10 years ago may have changed as we gather data and alter hypotheses to fit known facts. This is how science makes progress. Did you ever read something on the internet that you found out later was not true? Let's try to clear up a few common misconceptions about dinosaurs. You probably already know some of these, but you may not know them all.

Any prehistoric animal is called a dinosaur

This is a very common misconception. While this is really just a matter of semantics, it is still worth clarifying. The term "dinosaur" (deinos – terrible; sauros – lizard) was first coined by Sir Richard Owen in 1842 to describe large, extinct reptiles. For many years this definition was true but as the science of paleontology grew and our understanding of past life expanded, so changed our definition of what a dinosaur was. A dinosaur, as used by paleontologists today, refers to a specific group of animals, with *Tyrannosaurus rex* and *Triceratops* (fig. 1) being very good examples. Without going into too much detail, dinosaurs define their own group of animals. Not technically reptiles, birds, or mammals, dinosaurs are most closely related to crocodiles and other reptiles. While defining them exactly is beyond the scope of this article, know that all dinosaurs walked on land and all have their back legs situated directly beneath their hips (like mammals) rather than splaying outward like lizards and crocodiles. There are more specific definitions dealing with other features of their skeletal anatomy, such as the number of openings in their skulls, but those are not as relevant here. What this means is that those prehistoric animals you see on display at your local museum may not all be dinosaurs. Those pterosaurs (fig. 2) you see flying over your head are flying reptiles. The mosasaur (fig. 3) mounted in the underwater exhibit is a swimming reptile. The sabertooth cat you see attacking the bison (fig. 4) on the prairie: those are both mammals.

Figure 2. Skeletons of *Pteranodon* flying overhead at the Bismarck airport.

Figure 1. *Triceratops* and *Tyrannosaurus rex* locked in combat at the North Dakota Heritage Center and State Museum, Bismarck, ND.

Figure 3. Mosasaur skeleton on exhibit at the North Dakota Heritage Center and State Museum, Bismarck, ND.

Figure 4. *Bison latifrons* fending off two attacking *Smilodon fatalis* on exhibit at the North Dakota Heritage Center and State Museum, Bismarck, ND.

Figure 5. Vibrant colors of a cassowary at the Adelaide zoo in Austalia.

Dinosaurs are extinct

Picture a large, flightless bird that is alive today such as the ostrich, emu, or cassowary (fig. 5). Maybe it is the combination of scales on their feet and feathers on their body, or it could be just the overall look, but they seem to have an almost ancient feel about them. If you have seen these large birds today at the zoo or in the wild, you quickly realize how intimidating they can be. Now imagine them with teeth and razor sharp hand and foot claws running about not only in the wilds of North Dakota, but the world during the reign of the dinosaurs. Based only on their appearance, imagining birds to be modified dinosaurs is not such a difficult thing.

The idea of birds and dinosaurs being very closely related is not a new one. The notion was first proposed not long after the discovery of *Archaeopteryx* in the mid-1800s. The early idea stated that dinosaurs and birds had a very close common ancestor, that both branched from separately. This is now referred to as the non theropod hypothesis (Witmer, 2002) (fig. 6). The other idea is that birds evolved from within one branch of dinosaurs, more specifically the meat-eating dinosaurs (theropods). This later idea is known as the theropod hypothesis (Witmer, 2002) (fig. 7). Over the last 150 years or so since the discovery of *Archaeopteryx*, many new revelations have been made in the field and in the lab regarding the origins of birds. New techniques and ways of studying the evolutionary history of animals have been developed (i.e. cladistics), and additional fossils have been discovered that shed new light on the question like never before. The discovery of feathered dinosaurs in China in the 1990s was a big step in our understanding of bird origins.

Other than a few morphological oddities, the similarities between the extinct, meat-eating dinosaurs and modern birds are pretty remarkable. Hollow bones and the presence of wishbones and feathers are three pretty obvious similarities between meat-eating dinosaurs and birds, to name only a few. The idea continues to be debated among paleontologists to this day (Feduccia, 1996; Witmer, 2002), but most agree that modern birds have their origins within the dinosaur evolutionary tree as seen in figure 7.

We know what color dinosaurs were

As much as I would love to tell you that we know the colors of dinosaurs, we simply do not. There have recently been some dinosaur specimens collected with skin still intact, including Dakota (Hoganson, 2008), and these specimens would likely hold the key to learning skin/scale color but nothing has yet been discovered (fig. 8). In modern reptiles, birds, and mammals color is attained in the skin, scales, and feathers through pigments. It is unlikely that pigments would be preserved through the fossilization process causing these colors to be lost. However, color may also be attained through physical structures, not pigments. The iridescent colors of some butterflies, beetles, hummingbirds, pigeons, peacocks, and even soap bubbles are great examples of structural color. In structural color, the colors we see are determined by the thickness of the material and how light is reflected and refracted (bent) back to our eye based on the angle from which we are viewing the material. If paleontologists were to one day find the structure of dinosaur scales to be similar to that of a living iridescent bird, it would be exciting news indeed, and not out of the realm of possibility. The best place to infer the color of some dinosaurs is

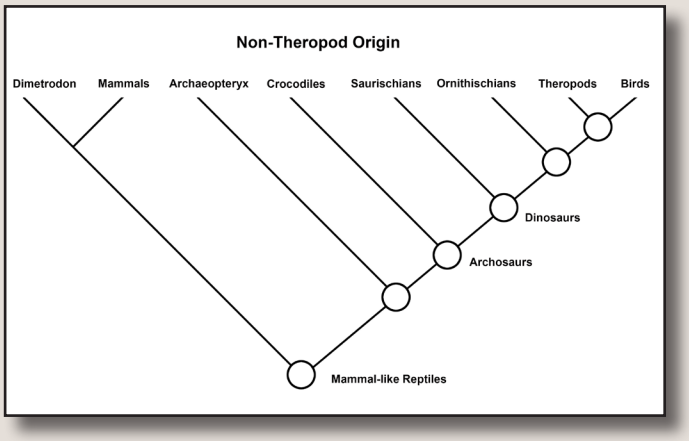

Figure 6. The non theropod origin of birds. Notice *Archaeopteryx* lies outside of the crocodiles and dinosaurs. This image also incorporates the latest hypothesis of saurischians being outside of ornithischians and theropods (Baron et al., 2017).

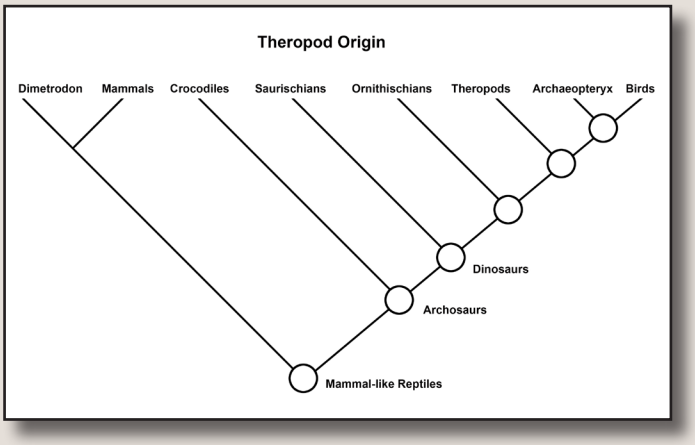

Figure 7. The theropod origin of birds. Notice *Archaeopteryx* lies within dinosaurs and theropods. This image also incorporates the latest hypothesis of saurischians being outside of ornithischians and theropods (Baron et al., 2017).

Figure 8. Close-up image of the skin of Dakota the dino-mummy.

to look at their closest living relatives, birds and crocodiles. While the color palate of crocodiles is pretty uniform, we all know how varied the colors of birds can be (fig. 5). As the evolutionary ancestors of birds, did the meat-eating dinosaurs pass on this color variety to modern birds or were they more close to the color palate of crocodiles? Unfortunately we do not know. Until we can figure that out, we will just have to rely on our imaginations.

All dinosaurs were large

When you hear the word dinosaur, I'm sure most people immediately think of the large lumbering beasts you have seen the skeletons of in museums across the country. Among the largest dinosaurs were the sauropods with their large bodies and long tails and necks. As of this writing the tallest known dinosaur is *Sauroposeidon* with its eyes approximately 40-45 feet (12-14 meters) above the ground (Wedel et al., 2000). At this height it was more than tall enough to look over the top of most houses (Fig. 9). In comparison, a male giraffe is a measly 20 feet tall (6 meters), pretty short by sauropod standards. Currently, the largest known dinosaur is *Argentinosaurus* with a length of 92 feet (28 meters) and an estimated 80 tons in weight (Hallett and Wedel, 2016). Compare that to the largest living animal on land today, the African elephant, which is approximately 11 feet tall (3 meters) and can weigh up to 6 tons (Hallett and Wedel, 2016). Elephants are practically puny in comparison to these extinct behemoths!

While it is true that some, and maybe even most, dinosaurs (on a relative scale) were large, with a few attaining truly massive sizes, others were relatively tiny when compared to modern animals. *Compsognathus* and *Fruitadens* were among the smallest dinosaurs that we know of and were just slightly larger than a chicken in both length (approximately 2 feet) and weight (1-2 pounds) (Fig. 9) (Fastovsky and Weishampel, 1996; Butler et al., 2009).

Mammals and dinosaurs did not coexist

This might be something you never actually even thought about. Some think of evolution happening in a straight line. I think of evolution as happening in an ever branching pattern, where the final result looks more like a very "twiggy bush" rather than an arrow. There is a relative direction to evolution in that it must build on what is already there, but is generally formless and unpredictable as it can move suddenly in unexpected directions.

Approximately 300 million years ago the ancestors of what we now call mammals branched off from their reptilian counterparts. We call this branch the mammal-like reptiles due to their transitional skeletal form between reptiles and mammals. Nearly 100 million years later dinosaurs branched off from the reptilian branch and mammals appeared from the mammal-like reptile branch (Fig. 7). It is interesting to think

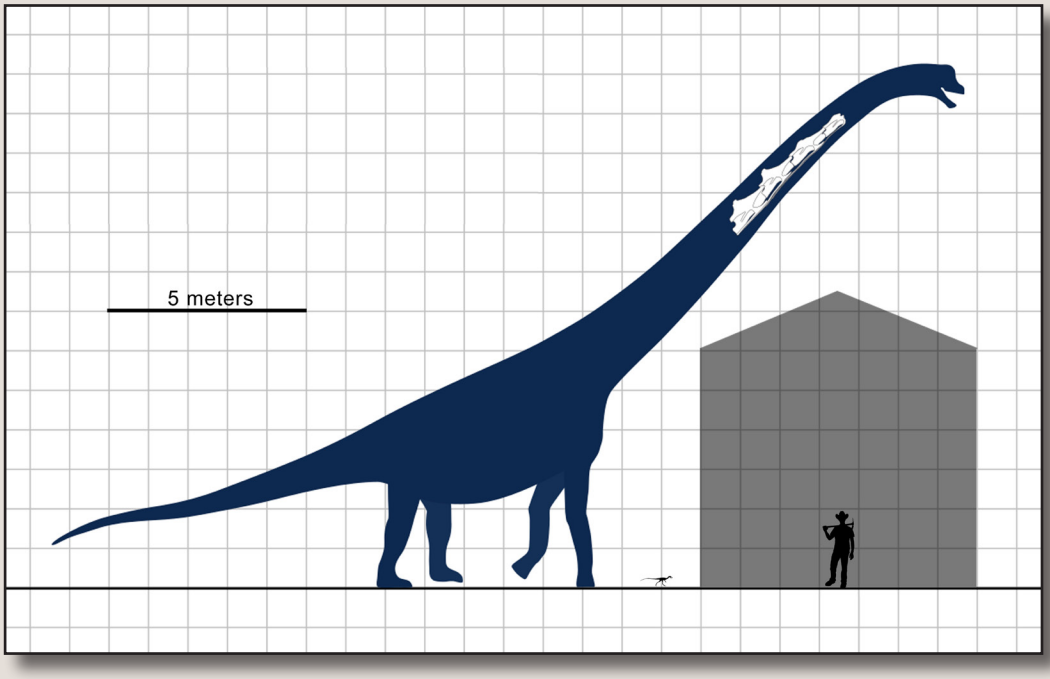

Figure 9. Silhouette image comparing *Sauroposeidon, Compsognathus, Homo sapiens,* and an "average" 25-foot-tall house.

that the first dinosaurs and the first true mammals appeared on Earth at nearly the same time. As we know, the dinosaurs dominated life on Earth for nearly 150 million years, many growing to tremendous size and filling nearly every available niche. Mammals however, tended to remain small during the same time, the largest being about the size of a Virginia opossum, and were probably nocturnal. Mammals at this time were likely feeding on small insects or other invertebrates and hiding from dinosaurs that may have been hunting them (fig. 10).

Figure 10. Image of a small Mesozoic mammal feeding on insects. Image by and courtesy of Mark Hallett.

Oil comes from dinosaurs

This idea is very common. Most people have a basic understanding that oil comes from dead plants, animals / organic matter. However the misconception comes when thinking about which animals that oil is coming from. I believe that a great deal of this misunderstanding comes from the Sinclair Oil symbol which is a small, green, sauropod dinosaur named "Dino" (fig. 11). The reason for this symbol has nothing to do with where the oil is coming from, but rather has a more historical story.

Back in the late 1800s and early 1900s dinosaurs were big business. Museums across the eastern United States were scrambling to get the "best" skeleton they could and out-do other museums. They all wanted the biggest, most complete, fiercest, etc. This was the time of the infamous dinosaur wars. One of the more prominent paleontologists at this time was a man named Barnum Brown. He was the discoverer of *Tyrannosaurus rex* in 1902 and was a very prolific fossil hunter (Osborn, 1905). Some say he was the greatest dinosaur fossil collector ever. In the early 1900s, Mr. Brown had a relationship with the Sinclair Oil Company. He assisted in writing promotional pamphlets and the design of stamps for the Sinclair Corporation in exchange for monetary support of his dinosaur collecting expeditions (Mitchell, 1998).

Figure 11. Sinclair dinosaur "Dino" in Midvale, Utah.

To capitalize on the popularity of dinosaurs "Dino" was created as a marketing tool aimed at getting customers to believe that better oil came from older rocks. One of their marketing signs claimed it was "mellowed 80 million years" (Spence, 1966). The public equated "Dino" with power, endurance, and stamina (Spence, 1966). I'm sure those were qualities that Sinclair was happy to be remembered for. Even though the pamphlets and stamp books make reference to how oil was formed even before the dinosaurs existed, it seems the association of "Dino" and oil was too difficult to separate.

> *"To give better academic stature to its promotions, Sinclair financed for several years the dinosaur fossil search expeditions of Dr. Barnum Brown, then curator of fossil reptiles at the American Museum of Natural History," (Spence, 1966).*

When plants and animals living in the world's oceans die, they sink to the ocean floor where their remains are eventually buried by sediment. Over time, as more of this organic matter is accumulated and buried deeper and deeper it begins to change. Once certain pressures and temperatures are reached underground, the organic material changes into a substance called kerogen. As kerogen is buried even deeper, the increasing temperature and pressure transform it into hydrocarbons – the main constituents of crude oil and gas (fig. 12). The hydrocarbons will migrate through the pore spaces in rocks and accumulate in natural traps and pool together. It is these traps and pools that oil companies are searching for when they drill oil wells. It was this same process that occurred in North Dakota and formed the Bakken crude that is being drilled today (Nordeng, 2014).

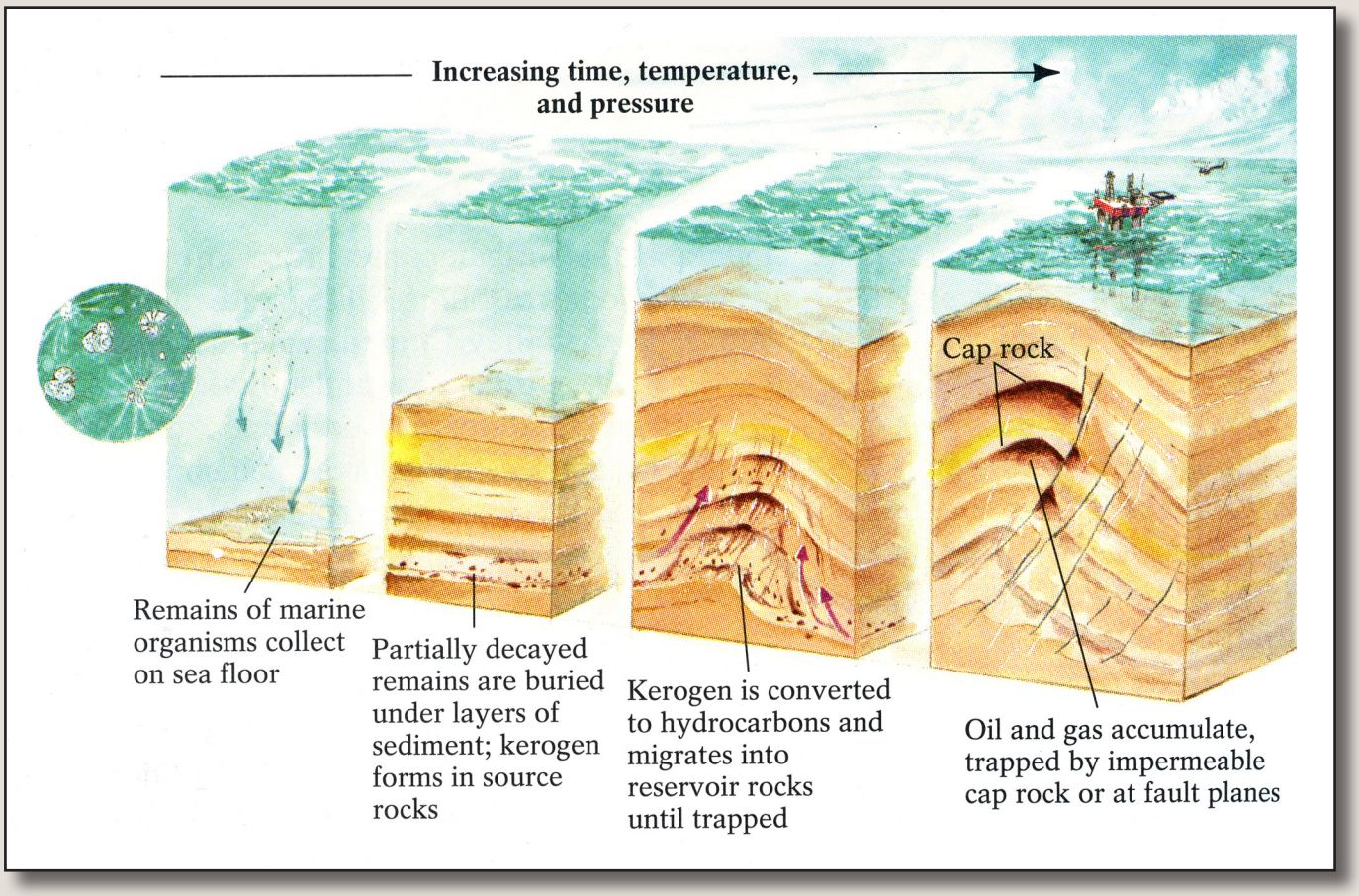

Figure 12. Illustrated explanation of how oil forms from Chernicoff, 1995.

Conclusions

So how did you do? Did you know some or all of these? Did any of them surprise you? Remember, what you were taught in school was correct when you learned it, but because of the nature of science, hypotheses are constantly being disproved and new ones replace them. The ability of scientific knowledge to change as new evidence is discovered and introduced is arguably its greatest strength. With that in mind, remember that there are many ideas and concepts that have changed over the years. Some ideas change a little, others change dramatically, but with each small change in how we look at the world, we see a little more of the truth.

References

Baron, M. G., Norman, D. B., and Barrett, P. M., 2017, A new hypothesis of dinosaur relationships and early dinosaur evolution: Nature, v. 543, p. 501-506.

Butler, R. J., Galton, P. M., Porro, L. B., Chiappe, L. M., Henderson, D. M., and Erickson, G. M., 2009, Lower limits of ornithischian dinosaur body size inferred from a new Upper Jurassic heterodontosaurid from North America: Proceedings of the Royal Society B, v. 277, p. 375-381.

Chernicoff, S., 1995, Geology, Worth Publishers, Inc., 593 pp.

Fastovsky, D. E., and Weishampel, D. B., 1996, The evolution and extinction of the dinosaurs, Cambridge University Press, 2nd Edition, 485 pp.

Feduccia, A., 1996, The origin and evolution of birds, Yale University Press, 420 pp.

Hallett, M., and Wedel, M. J., 2016, The sauropod dinosaurs, John Hopkins University Press, 320 pp.

Hoganson, J. W., 2008, Dakota - A mummified dinosaur: DMR newsletter, v. 35, no. 2, p. 1-3.

Mitchell, W. J. T., 1998, The last dinosaur book, The University of Chicago Press, 321 pp.

Nordeng, S. H., 2014, Building the science for advancing oil and gas exploration and development in the Williston Basin: Geo News, v. 41, no. 1, p. 14-18.

Osborn, H. F., 1905, *Tyrannosaurus* and other Cretaceous carnivorous dinosaurs: American Museum of Natural History, Bulletin 21, p. 259-265.

Spence, H., 1966, A Great Name in Oil, Sinclair Through Fifty Years, F. W. Dodge Co. / McGraw Hill Inc., 104 pp.

Wedel, M. J., Cifelli, R. L., and Sanders, K., 2000, *Sauroposeidon proteles*, a new sauropod from the Early Cretaceous of Oklahoma: Journal of Vertebrate Paleontology, v. 20, no. 1, p. 109-114.

Witmer, L. M., 2002, The debate on avian ancestry, phylogeny, function, and fossils, *in*, Chiappe, L. M., and Witmer, L. M., eds., Mesozoic birds, above the heads of dinosaurs, University of California Press, Berkeley, CA, p. 3-30.