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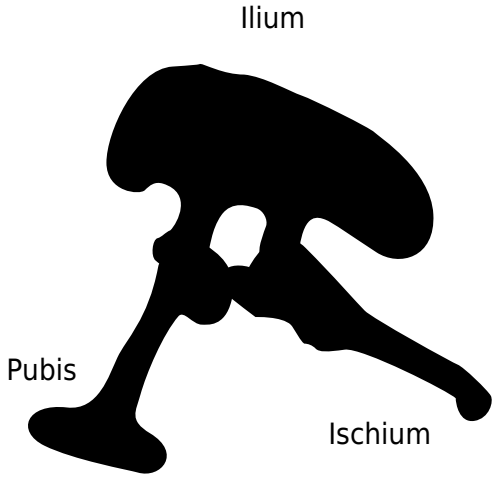
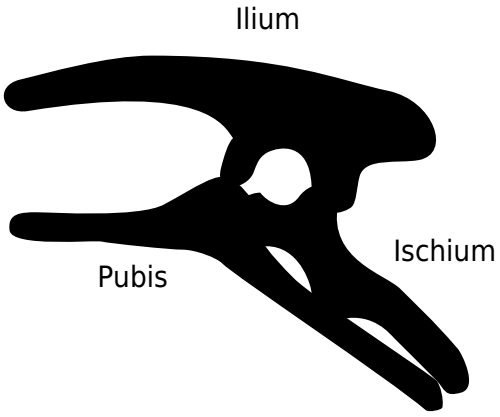
# Wouldn't It Be Interesting To Test That? [3]

As a paleontologist, I never studied dinosaurs, but I am still a sucker for good dinosaur research. And last month, a doozy of a paper was released [4]. A few headlines: "Dinosaur family tree poised for colossal shake-up [5]"; "Shaking up the dinosaur family tree [6]"; "New study restructures the dinosaur family tree [7]"; and my favorite: "A novel phylogenetic hypothesis for Dinosauria!? Shock! Horror!—Say it isn't so!!! [8]" Usually, headlines like these are hyperbole—it's not that the tree is being uprooted as much as it is that a tiny twiglet at the end of one branch is getting a little adjustment—but not this time. To understand, we need to talk dino hips. Because although according to Shakira [9], "hips don't lie," it turns out that they might mislead.




For 130 years, dinosaurs have been organized into two groups based on the structure of their hips. Mammals, birds, and most reptiles have hips composed of three major bones: the ilium, the ischium, and the pubis. A dinosaur's ilium forms the upper part of the hips and the two other bones attach underneath. The ischium bone points rearward, toward the tail end of the animal in all dinosaurs, but the pubis's orientation differs. Saurischians, the group that included the theropods and the long-necked sauropods, had a pubis that pointed toward the front of the animal. Ornithischians, which included everything else, had a pubis bone oriented parallel to the ischium, pointing rearwards. Birds have backwards-pointing pubis bones, which is where ornithischians got their name—"ornithischia" literally means "bird-hipped." ("Saurischia" means "lizard-hipped"; more on that in a moment.)

This all sounds neat and tidy, but it never worked that well. Many late-evolving theropods (including, for example, *Velociraptor* [10]) had a backwards-pointing pubis, including those from which birds evolved. So the bird-hipped dinosaurs did not include birds, while the lizard-hipped dinosaurs included dinosaurs with decidedly *un*-lizard-like hips, including birds. (And it's even worse that that because dinosaurs aren't lizards at all [11]; they're members of a group of reptiles called archosaurs.) Ornithischia was given its name a long time ago (in 1887), but in paleontology, names are forever.



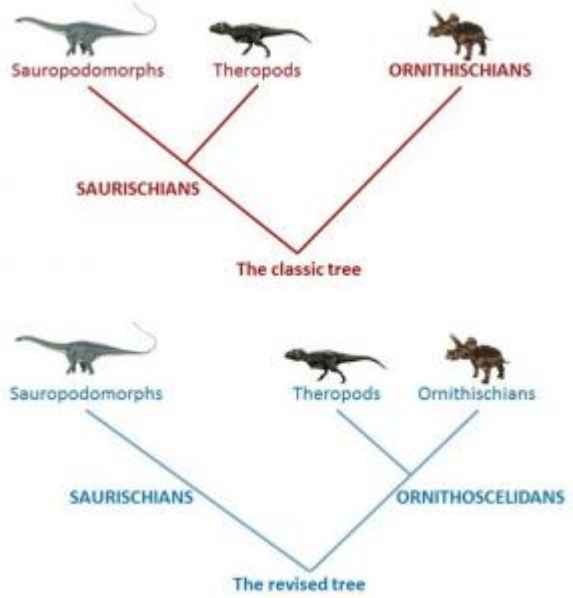

What is not always forever, however, is an accepted hypothesis. Evolutionary trees are hypotheses based on analyses of traits. For 130 years, the basic shape of the dinosaur tree remained: sauropods and theropods (saurischians) on one side, everything else (ornithischians) on the other. When new specimens came along, the dinosaur tree grew, but it always maintained its basic split trunk structure. Until Matthew Baron came along.

A Ph.D. student at Cambridge University, Baron became intrigued by how theropod-like early ornithischians were, and he began to wonder whether we should re-evaluate the basic shape of the dinosaur tree. Stripping away all preconceptions, Baron approached every one of the 74 dinosaurs in his data set as a blank slate. He compiled a list of 457 physical traits, recording their presence or absence in each of his dinosaurs. Some of these characteristics were typical of ornithischians, others of saurischians, but he ignored those classifications when doing his work. Three years later, when a computer crunched his data, constructing 32 billion (!) possible trees in just under five minutes, the best-supported trees scooted the theropods over with the ornithischians, forming a group called Ornithoscelida (a name originally proposed by none other than Darwin's bulldog Thomas Henry Huxley back in 1869—Baron is reviving it. How retro!).

This isn't just tossing a word salad; it's a big deal. As Ed Yong explained it [12], if Baron is right, it's "like someone telling you that neither cats nor dogs are what you thought they were, and some of the animals you call 'cats' are actually dogs." I'm going to skip over a ton of details and conclusions—from new hypotheses about diet and the origin of feathers to the placement of a weird group of animals called the herrerasaurids—to focus on what makes this research a golden opportunity if you happen to be an educator.

How many times have you heard a student start a question with "Sorry, but…" or "I have a dumb question…"? Or how many times have you been guilty of that yourself? It's a particularly pervasive behavior and also, I'd argue, a damaging one. Questions are the very springs of science. You simply cannot shy away from asking questions if you want to pursue science, so thinking your question isn't worth asking is akin to giving up before you ever get started. Recounting the story, Baron says that other paleontologists had been "sniffing around" early ornithischian dinosaur fossils and wondering about why they looked so theropod-like, but because the existing groupings had been dogma for more than a century, they didn't pursue it.

Baron could have figured it wasn't worth questioning either—that it'd be dumb to ask whether we might




have had it wrong, that maybe theropods should be over on the ornithischian side of the tree—but he didn't. Instead, he went to his advisor, David Norman, who "had this wry smile and confessed that he always had a the same hunch." Norman said to Baron, "Wouldn't it be interesting to test that?"

And so he did. Stripping away all preconceptions, Baron approached every one of the 74 dinosaurs in his

data set as a blank slate. He had a list of 457 physical traits that he set out to analyze in each dinosaur. Some of these characteristics were typical of ornithischians, others of saurischians, but he ignored those classifications when doing his work. If a trait didn't apply, it didn't apply—but he still checked. No shortcuts. And it turns out that, at least according to Baron's data, the old saurischian-ornithischian dogma couldn't stand up against the evidence.

Here we come to the moral of the story. A young not-yet-minted paleontologist might have just rewritten the book on dinosaurs because he asked the right questions and did the work. How great is that? Even greater is that we get to keep asking questions like these, trying with each iteration to get closer to the truth. Tomorrow, a new fossil or a reinterpretation of an old fossil might shake things up again. The problem will never been completely solved; the questions will never all be completely answered. Writing for *Scientific American*'s blog, Darren Naish put it this way [13]: "[S]cience is about skepticism, and no hypothesis is ever a definitive 'last word' on a subject." While some may regard that as a weakness, an admission that scientists don't know anything, it is in reality science's greatest strength.

So I suggest you tell this story to your students. And the next time someone starts in with "This is probably a dumb question, but…" cut them off. Remind them that for all they know, their "dumb" question might end up rewriting the science book. And if you are asked a question you don't know the answer to, don't dodge it—instead, say, "Wouldn't it be interesting to test that?" because you never know what will happen when you do.

*Are you a teacher and want to tell us about an* amazing free resource [14]*? Do you have an idea for a* Misconception Monday [15] *or other type of post? Have a* fossil to share [16]*? See some good or bad examples of* science communication [17] *lately? Drop me an* e-mail [18] *or shoot me a Tweet @keeps3.*

+ read [3]

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