Sauropod Vertebra Picture of the Week

If I could dissect a sauropod...

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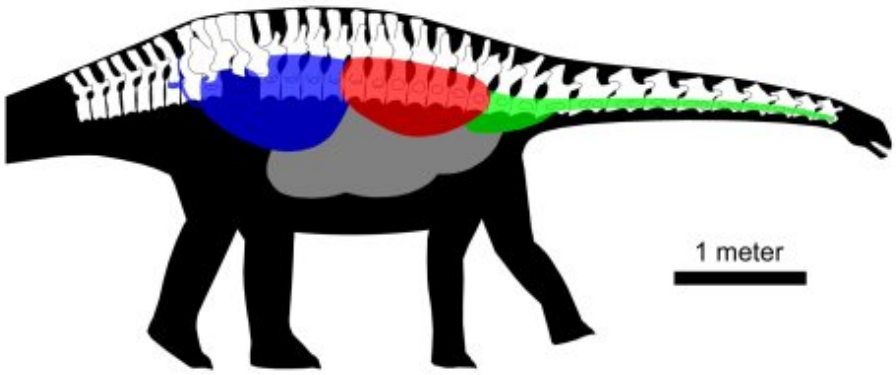
Abstract

Luke Horton asked in a comment on a recent post: Given the chance to examine a titanosaur cadaver with your hypothetical army of anatomists, what would you look for first? *FACEPALM* How we've gone almost 17 years without posting about a hypothetical sauropod dissection is quite beyond my capacity.



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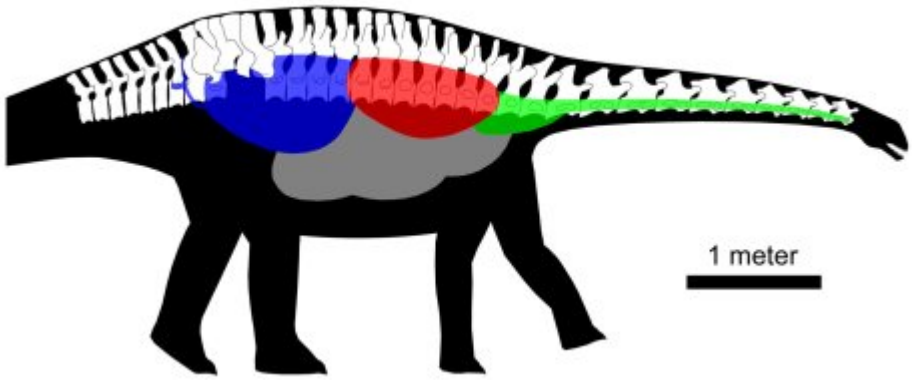
Luke Horton asked in a comment on a recent post:

> *Given the chance to examine a titanosaur cadaver with your hypothetical army of anatomists, what would you look for first?*

FACEPALM How we've gone almost 17 years without posting about a hypothetical sauropod dissection is quite beyond my capacity. I am also contractually obligated to remind you that the TV show "Inside Nature's Giants" shows dissections of a whale, elephant, giraffe, tiger, anaconda, giant squid, etc., so it's probably the closest we'll ever get. Go look up photos of Dr. Joy Reidenberg standing, um, *amidst* a partially-dissected whale, or just watch that episode, and your sauropod-dissection-visualizer will be properly calibrated.

To get back to Luke's question, there are loads of interesting things that could be dissected in a sauropod, but since the remit here is Matt Wedel x titanosaur, there's only one possible answer: the lung/air sac system and its diverticula. For several reasons:



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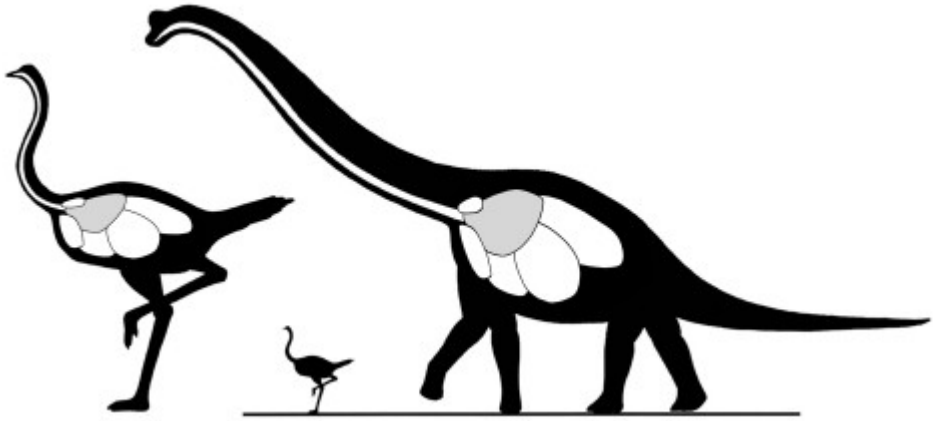
Hypothetical reconstruction of the lungs (red) and air sacs (blue, green, and gray) in *Haplocanthosaurus* CM 879. I'd love to know how close this is to reality. Wedel (2009: fig. 10).

First and most obviously, I've spent the last quarter-century trying to infer as much as possible about the respiratory systems of sauropods based on the patterns of pneumaticity in their skeletons, and I'd kill for the opportunity to check the accuracy of my inferences — and those of

all my fellow-travelers in the sauropod and dinosaur respiration biz, like Daniela Schwarz and Emma Schachner and Tito Aureliano and many others.



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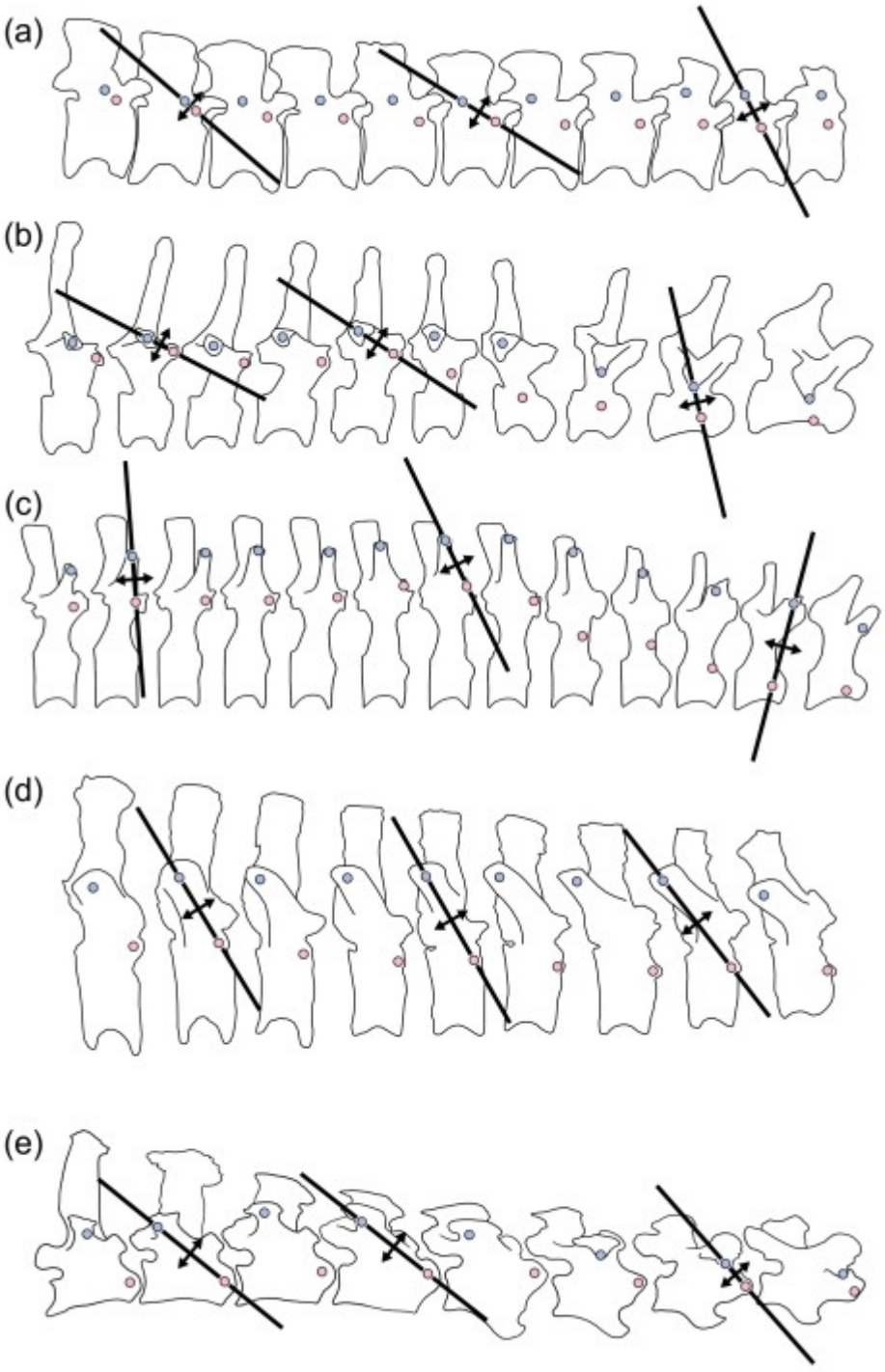
Sauropod respiratory system modeled on that of a bird. I'll bet the correspondence wasn't *this* close. (Also, since making this figure 20 years ago, I've learned that the abdominal air sacs of ostriches are actually rather small, although the perirenal, femoral, and subcutaneous diverticula of the abdominal air sacs are extensive; see Bezuidenhout et al. 1999). Wedel and Cifelli (2005: fig. 14).

Second, I am intrigued/haunted by the possibility that extant birds might not represent the apex of saurischian lung/air sac evolution. Birds survived the K-Pg disaster because they were small; respiratory efficiency had little or nothing to do with it (evidence: all the other small-bodied tetrapods that survived, like the many, many squamate and mammalian lineages). To me it would be a wild coincidence if the tiny dinosaurs that survived also just happened to be The Bestest (TM) at some anatomical/physiological thing unrelated to their survival. In fact, given how sensitive birds are to airborne dust and ash, I wonder if their fancy lungs weren't more of a hindrance than a help in the dusty, sooty, iridium-laced post-impact world. Anyway, there are interesting clues that the air sac systems of extant birds are just one subset of a much greater original diversity, like most (all?) birds starting out embryologically with a dozen or so air sacs, which get simplified to the usual 9 or fewer by fusions. What did other dinosaurs do with their 12 (or more?) air sacs? If any dinosaurian clade was going to push the capabilities of the "avian"

lung/air sac system in interesting directions and to fascinating extremes, sauropods seem like a good bet.



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Rib articulation angles in the dorsal vertebrae of (a) *Lufengosaurus*, (b) *Diplodocus*, (c) *Haplocanthosaurus*, (d) *Tyrannosaurus*, and (e) an ostrich. Anterior is to the right. *Diplodocus* and *Haplocanthosaurus* are pretty wildly different considering they coexisted in the Morrison. I really gotta write a whole post about that. Boisvert et al. (2024: fig. 12).

So I'm intrigued by the idea that extant birds show us one way that a saurischian lung/air sac system can work, but don't exhaust the territory, anymore than kangaroos show us all the ways that mammals can reproduce. Maybe sauropods had even better lungs than birds! Or maybe not. Likely they were doing their own weirdly specialized thing — or many weirdly specialized things — that left few to no diagnostic traces in their skeletons. We can be pretty confident that at least some of the pneumatic diverticula of sauropods worked essentially identically to how they do in birds (see Woodruff et al. 2022 and this post), and mid-dorsal pneumatic hiatuses in juvenile sauropods — predicted by me in 2003, found by Melstrom et al. (2016) and Hanik et al. (2017) — suggest that their air sac systems were broadly comparable. On the other hand, the variety of rib articulation angles just within Morrison sauropods tells us they weren't all ventilating their air sacs in quite the same way (Boisvert et al. 2024), despite broad similarities with other dinos at the levels of rib osteology (Wang et al. 2023) and whole-thorax construction (Schachner et al. 2009, 2011). (Aside: why the *hell* didn't I work a citation of Wang et al. 2023 into the Dry Mesa Haplo paper? I can only conclude that I am at least occasionally an idiot.) Whatever was going on, I'm pretty sure sauropods didn't look exactly like 60-ton turkeys on the inside, but we don't have a ton of real data on how they differed. It would be amazing to find out.

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The mounted *Rapetosaurus* skeleton at the Field Museum, traced from a photo. Specific weird things to note: neck about twice as long as tail, cervical vertebrae about twice as tall as dorsals, and smallish pelvic bones relative to hindlimbs (= skinny posterior abdomen, at least dorsoventrally). See this post for details.

Third, if any sauropods were going to rival or exceed birds in fancy under-the-hood anatomical and physiological adaptations, my money would be on titanosaurs. They were morphologically disparate, phylogenetically diverse, geographically widespread, they independently evolved to giant size more times than any other sauropod clade, and their growth rates were wild. I'd dissect any sauropod I got access to (uh duh), but a titanosaur would be particularly appealing. Which titanosaur? Probably *Rapetosaurus*: we know it grew very fast early on (Curry Rogers et al. 2016, and see implications for the nervous system in Smith et al. 2022), it had a highly pneumatic vertebral column (O'Connor 2006), its body proportions were pretty wacky, and it had other features of interest to me, like expanded neurocentral joints (see Wedel and Atterholt 2023 and this post) and neural canal ridges (see Atterholt et al. 2024 and this post).

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Sauropod Vertebra Picture of the Week

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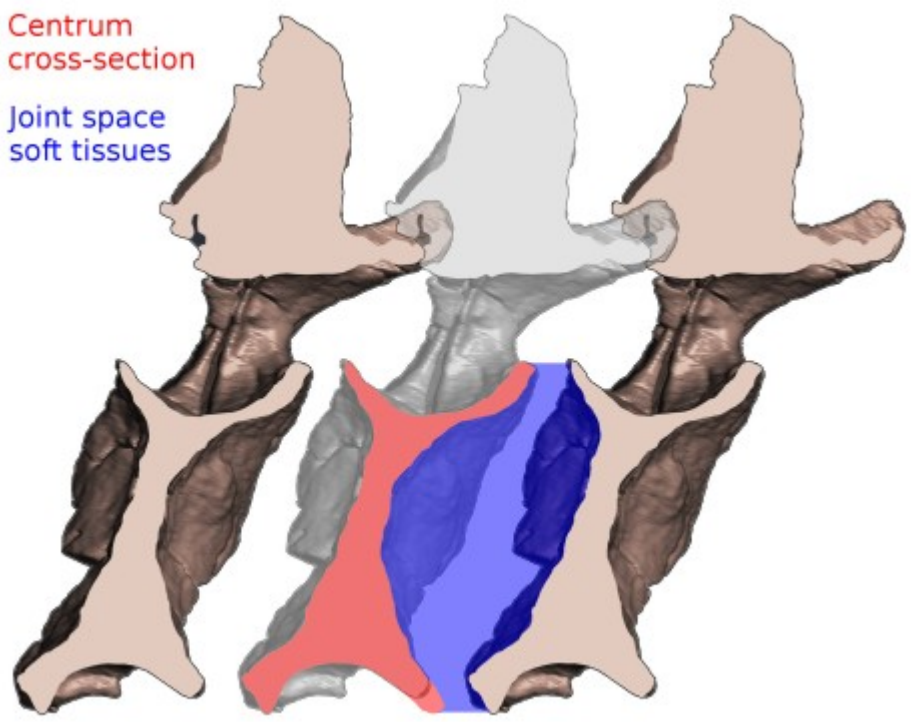
I used this photo of a *Rapetosaurus* caudal vertebra a few posts ago to illustrate the neural canal ridges, but — like many other sauropods — it also has very expanded neurocentral joints forming boutons. From Curry Rogers (2009: fig. 27).

Oh, and if I got to dissect more than one sauropod, the rest of my top 5 choices in order would be:

- the owner of BYU 9024 (*Supersaurus*? Giant ancient individual of *Barosaurus*? Are those even different things? Dissecting this critter could tell us!), *Barosaurus* being the most diplodocid-y and least titanosaur-y neosauropod I know of, and BYU 9024 being from a hellaciously big individual no matter what its classification;
- the Snowmass *Haplocanthosaurus*, because I have just so many questions about all the weird stuff going on with its tail (see Wedel et al. 2021 and this post for starters);
- *Omeisaurus* or *Xinjiangtitan*, to represent a maximally derived-but-also-weird non-neosauropod;
- *Sauroposeidon*, for obvious emotional reasons (but not enough to dethrone the others).

After that? Probably *Isanosaurus* or *Melanorosaurus* or something else waaaay down the tree, so I could see how much of the sauropod kit was in place from the get-go (probably most of it).



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Bone vs joint space in the proximal caudals of the Snowmass *Haplocanthosaurus*. I'd give one non-essential organ to dissect that tail!

And after the respiratory system, next up for me would be the spinal cord and any related morphological specializations of the neural canal — see Table 3 in Atterholt et al. (2024) for a running tally, and this page. Then intervertebral joints, digestive tract, and reproductive system (neither of the last two leave anything useful in the way of skeletal traces), in that order. Arguably the intervertebral joints would be a bigger score for sauropod paleobiology than spinal cord stuff, but maybe not, and having squelched my emotional pick among sauropod taxa, I'm letting my emotions rule when choosing body systems to dissect. I also am intensely interested in the possibility of protofeathers in sauropods, but you don't have to dissect those, you can just see if any are present, so I'd cheat a little and note any integumentary specializations *en passant*. (Remember than an animal can *have hairs* without being *hairy* [naked mole rats, rhinos, manatees, dolphins], ditto for feathers.)

So that's the sauropod and the body system I'd dissect first, if given the chance. What's your answer?

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