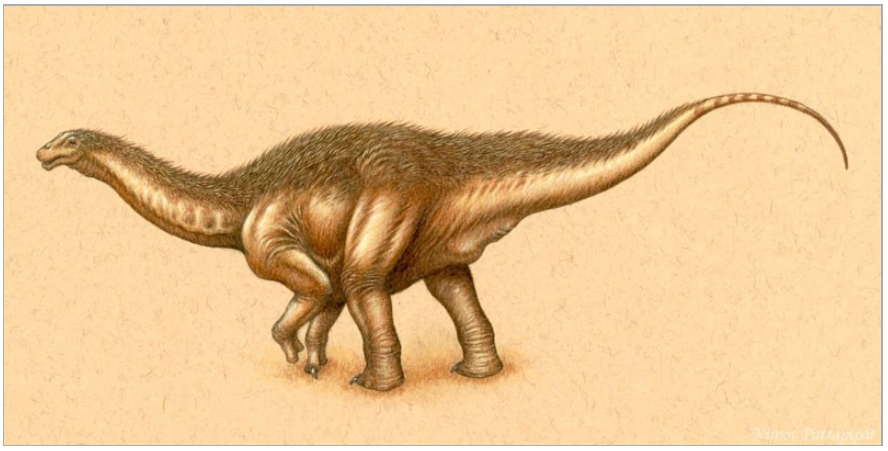
April 19, 2013, 10 a.m.

Diplodocus with feathers? Why we should take fuzzy sauropods seriously



MIKE TAYLOR - The idea of feathered sauropods - long-necked dinosaurs like *Diplodocus* - may seem pretty outlandish. Actually, it's been floating around for a while - though more often in pubs after conferences than in the technical literature.

The idea goes back at least to 1994, when the palaeoartist Greg Paul illustrated a hypothetic hatchling, straight from its egg and as cute as Littlefoot from *The Land Before Time*, with a covering of fine down.

There's very solid evidence for feathers in theropods, the two-legged meat-eating cousins of sauropods. There are lots of beautiful specimens that preserve feathers, or at least primitive filament-like 'protofeathers'.

These fossils represent many different theropod groups. There's even a nine-metre-long feathered tyrannosaur, which at 1.5 tonnes weighed ten times as much as any living bird. Whatever debate there used to be about feathered theropods, it's over. They had feathers, and the naked raptors of *Jurassic Park* are just plain wrong.

But things aren't nearly so clear-cut for sauropods. There are no known sauropod fossils that preserve feathers – not even the protofeathers that are often found on the less bird-like theropods. There are a few patches of fossilised sauropod skin – not many, as skin doesn't easily fossilise – but they all show the same thing: pebbly, non-overlapping scales.

So is it case closed? Not quite. Lots of animals have different kinds of covering on different parts of their bodies. Chickens have scaly legs, but feathers elsewhere. Elephants are mostly naked, but have tufts of hair on their tails. (It's amusing to imagine sauropods with flamboyant tufts of brightly coloured feathers sprouting from the tips of their tails.)

For that matter, we humans have a pretty funny distribution of hair on our bodies. No future palaeontologist, looking at fossilised skin from a human elbow, would guess that we have hair in our armpits.

So we don't have firm evidence that sauropods *didn't* have feathers; but what reason do we have to think that they did? The answer lies in 'phylogenetic bracketing'. As the Ukrainian biologist Theodosius Dobzhansky said, "nothing in biology makes sense except in the light of evolution", and to understand sauropods properly, we need to understand who they are related to – in other words, where they fit in the phylogeny, or evolutionary tree.

Sauropods' nearest relatives are the theropods, which we know had feathers. But that's not enough to let us to draw conclusions about sauropods, as feathers might have evolved within the theropod group. We need to look at the next closest relatives as well – and that is the third great group of dinosaurs, the ornithischians, which include *Triceratops* and *Edmontosaurus*.

Only a few years ago, scientists thought that the ornithischians had naked skin, but that changed in 2009 when a tiny fuzzy ornithischian called *Tianyulong* was announced. Here's why this is important for sauropods: if theropods and ornithischians both had protofeathers, then it's most likely that they inherited them from their common ancestor.

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And since that animal was also the ancestor of sauropods, it's likely that they inherited protofeathers from that ancestor. The two feathered groups, theropods and ornithischians, bracket sauropods on the family tree – they form a 'phylogenetic bracket'.

If this seems like special pleading, it's not: it's the same reasoning we use to deduce that dinosaurs had eyeballs. Eyes don't fossilise, so we don't have direct evidence; but birds and crocs, dinosaurs' nearest living relatives, both have eyeballs. So they probably got them from their common ancestor, and the other descendants of that ancestor probably retained them, too.

Of course it's not always that simple. Our ancestors had hair over all of their bodies, but we've lost most of it. In the same way, even if sauropods did inherit protofeathers from their ancestors, they might have lost them, just as large modern mammals like elephants, rhinos and hippos have discarded most of their hair.

To resolve this, we really want a smoking gun – a sauropod fossil that directly preserves feathers. Unfortunately, there are good reasons why we might not get one. Big animals fossilise when a lot of sediment accumulates at once – enough to bury the whole body. But this usually happens only with coarse-grained sediments that aren't able to record impressions of delicate structures like feathers. Fine sediments that do preserve feathers accumulate too slowly to bury a sauropod.

But you never know. One day someone might find the fossil we're looking for!

- Dr. Mike Taylor is a computer programmer in his day-job, and a Research Associate at the University of Bristol. He has the luxury of working almost exclusively on sauropods, the most impressive and inspiring of all dinosaurs.

- Illustration by Niroot Puttapipat for 'My Beloved Brontosaurus' by Brian Switek

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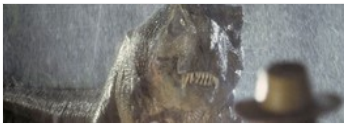

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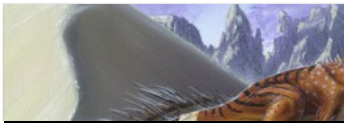

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