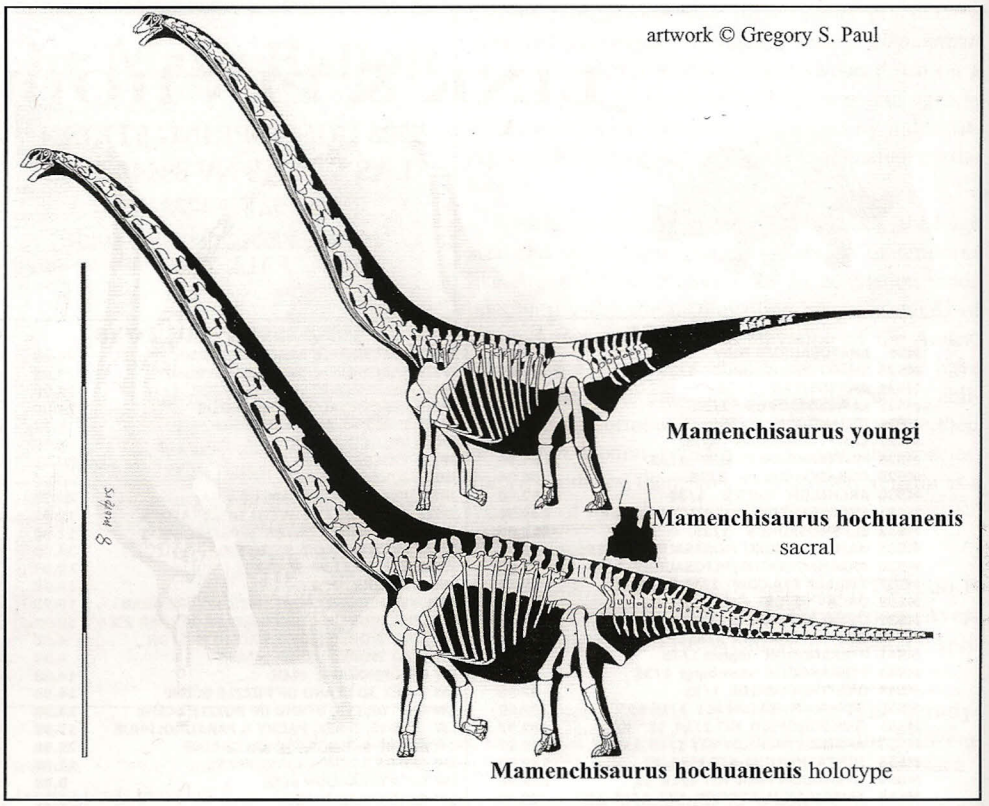
Mamenchisaurus youngi, the Dorky Dinosaur

by Gregory S. Paul



Over the years a slew of species of the Late Jurassic genus **Mamenchisaurus** have come out of China, most from the Upper Shaxiamiao Formation. So many species of one genus from such a limited time and place is suspicious, one suspects either some oversplitting at the species level, or overlumping at the genus level. But in any case one of the best skeletons yet described is the nearly complete skull and skeleton of the holotype of **Mamenchisaurus youngi**, which was found largely articulated.

In my never ending task of restoring the skeletons of dinosaurs I sat down to do **Mamenchisaurus youngi**, but a problem soon arose. In sauropods the sacrum is somewhat wedge shaped, with the bottom of the combined sacrals significantly longer than the comparable length of the top edge of the neural spines. The result is that the sacrum and then the tail base are sequentially pitched upwards to a modest degree relative to the posterior dorsals. The **Mamenchisaurus youngi** skeleton was restored and mounted in a conventional if rather old fashioned low tailed pose as can be seen in the extensive monograph describing the ancient beast by Ouyang and Ye. That's where the problem began. In the monograph the vertebrae are figured and photographed in detail, ideal for articulating them in the initial skeletal drawing. This researcher was perplexed by an inability to put the dorsal-sacral-caudal series together in the manner normal for sauropods. Just would not work. Examination of the photograph of the mounted skeleton in Ouyang and Ye revealed the problem. The zygapophyses of at least five dorsals and the first four caudals are grossly disarticulated, being pulled far from one another in an attempt to achieve a relatively straight vertebral column. It is a huge error that had to be corrected. When the vertebrae in front of behind the sacrum are properly articulated with the zygapophyses in normal articulation, then the dorsal column and tail are flexed upwards an extreme ~35 degrees relative to one another. It's bizarre and to be blunt about it rather dorky, no other sauropod to date is like it.

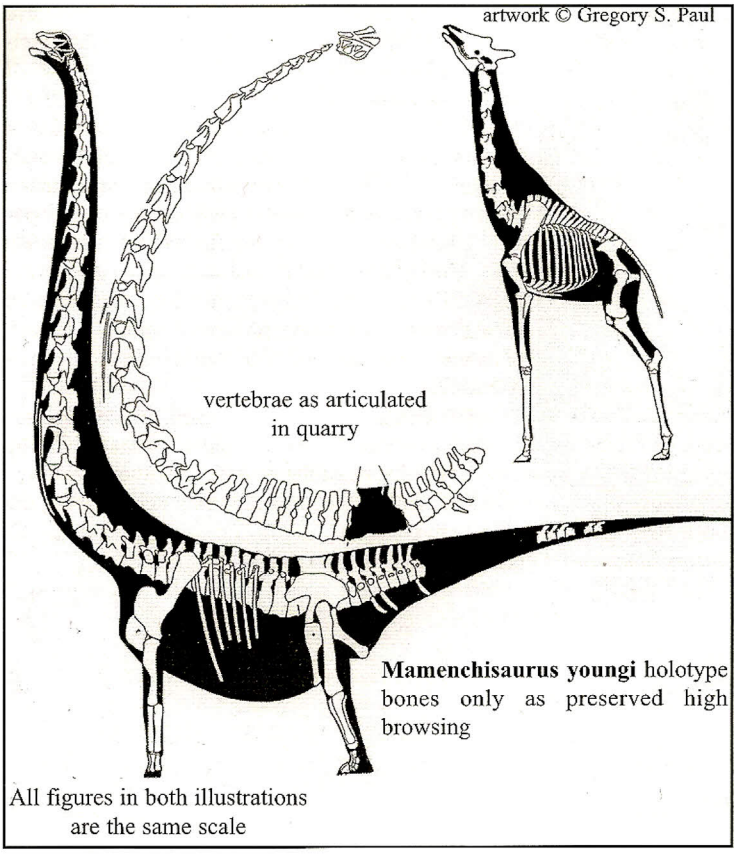
The extreme dorso-flexion creates a pronounced V-shaped profile around the hips that is 25 degrees greater than **Mamenchisaurus hochuanensis**. The tail itself is pitched ~20 degrees above horizontal; there is no evidence that the tail base vertebrae were beveled to make the rest of the tail horizontal so it probably walked about with its tail sticking up. When I finished articulating the vertebrae I realized that it closely matched the position the skeleton was found in the quarry according to the map. The hyper-flexion is all too real. And the source of the strong V-flexion is obvious. The beveling of the sacrum is more acute than in any other sauropod , which exaggerates its wedge shape compared to other sauropods including **Mamenchisaurus hochuanensis**. That these two dinosaurs are so different in this particular regard is interesting because bone for bone they are hard to tell apart. It will be interesting to see if other specimens of **Mamenchisaurus youngi**, or other mamenchisaurs or sauropods for that matter, have V profiles. It is possible that it was a sexual character of some sort, but is just as likely to be a characteristic of the species.

It is now known that mamenchisaurs had fairly long arms relative to the legs, so they were somewhat shoulder high. The V-flexion makes **Mamenchisaurus youngi** look rather giraffe-like, However, mamenchisaurs had unusually short legs for sauropods relative to their mass, which was about 13.8 tonnes for **Mamenchisaurus hochuanenis** and 6.7 for **Mamenchisaurus youngi**.

The position of the skeleton in the quarry tells us something else. The neck is articulated in a gently curving upwards arc that places the head many meters above the back. This vertical neck posture was achieved by flexing each neck vertebrae just a few degrees upwards relative to the next one in the series. I pointed out at the 2006 Society of Vertebrate Paleontology meeting that the only known co-fused sauropod neck base vertebrae are from a **Camarasaurus** described by Osborn and Mook back in 1921. The two vertebrae are frozen flexed upwards about 10 degrees, so there is no reason to doubt that high shouldered sauropods could easily raise their necks vertically, and did so often. The upwards pitch of the neck base of **Mamenchisaurus youngi** created by its V-shaped hip region facilitated reaching vertically. This view is reinforced in an interesting paper by Marshall and Padian that shows that the supposed "death pose" dinosaur skeletons are often found in is not a death posture at all. It occurs as animals, apparently those with high metabolic rates, are dying, and does not exceed the limits that could be normally adopted in life.

I also showed in my 2006 SVP poster that the basic idea of restoring "neutral" neck posture in long necked animals is probably not all that practical for a number of reasons, including the fact that using the method on different giraffe necks gives different results, not an encouraging development. Once the cartilage separating the vertebrae is gone it is not possible to accurately restore the "natural" position of the neck, which may not be set at one level in all long necked animals in any case. But it does not matter. The neutral neck posture is not tightly related to the level animals feed at in any case. At most the neutral posture is of interest to artists and those mounting skeletons. Yet that interest is limited because it is entirely valid to pose a neck in whatever position is desired just like with tails and legs, as long as the posture does not violate the functional anatomy and plausible range of movement of the subject. The posture shown here is a plausible but unavoidably semi-arbitrary choice that mamenchisaurs and similar sauropods may have adopted when walking, or maybe not. You want to show your mamenchisaur with the head all the way down drinking, go right ahead. Horizontal is okay too. At 45 degrees or vertical? Why not? Have the neck arced back so far that the head is touching the back? Not a good idea; probably goes beyond what the articulations allowed.

With the neck straight up **Mamenchisaurus youngi** could reach over 30 ft. (9.4 m), bigger **Mamenchisaurus hochuanenis** over 40 ft. (12.4 m). The



ability of sauropods like mamenchisaurs with necks far longer than those of the tallest mammals to easily raise their necks straight up means they had the ability to get blood all the way up there against the gravity well of the planet, which requires oversized hearts pumping blood at very high pressures (please do not get into how animals might use various circulatory tricks to be super tall without extreme BPs; there is no evidence they are workable). As I explained in 1998 such large, hard working hearts in turn would have boosted metabolic rates to high levels, so the sauropods energy budgets and food requirements were probably like those of mammals of similar size. Breathing through the long trachea that go along with super necks is another problem. Some extinct reptiles including the plesiosaurs were able to do so with dead end lungs, probably because they had low metabolic rates. Much more energetic giraffes seem to have some problems breathing, so the combination of much longer trachea with a mammal like metabolism probably required the evolution of flow through, air sac lungs in sauropods. The reason for going to all this trouble was to access the large amounts of nutritious plant material available in tree crowns that shorter animals cannot reach. In addition to air sac driven respiration, the small heads of sauropods were critical to allowing sauropods to evolve necks so much longer than in any mammal, whose heads include the heavy, food processing dental batteries. I, in 1998, and Christiansen in 1999, showed that the mouths of sauropods were actually about as broad relative to body mass as are those of herbivorous ratites and mammals, so the super dinosaurs did not have a problem feeding their enormous appetites with their small heads.

Christiansen, P. 1999. On the head size of sauropodomorph dinosaurs: implications for ecology and physiology. Historical Biology 13: 269-297.

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Memoirs American Museum of Natural History (NS) III: 247-287. Ouyang, H. & Ye, Y. 2002. The first Mamenchisaurian skeleton with complete skull

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