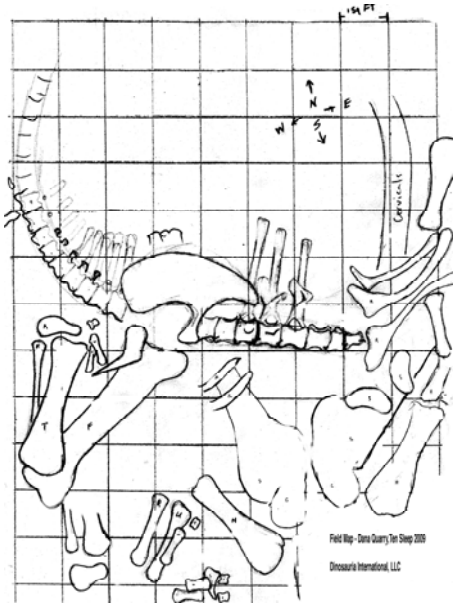
NEW SAUROPOD DISCOVERY

Wesley Linster poses with new diplodocid showing complete articulated vertebrae

INTRODUCTION

The Dana Quarry has yielded magnificent dinosaur discoveries. One specimen, nicknamed "Twinky", is particularly endearing due to its small size and exquisite state of preservation. Discovered in the spring of 2009, this new diplodocid is both the first complete specimen belonging to a young individual, and the only one to have preserved a nearly complete axial skeleton. There are no comparable specimens housed in museum collections quite like "Twinky". In complete paleontological context, this outstanding specimen offers unique opportunities to study ontogenetic development in sauropods, as it is part of a rare population sample.



Field map

DESCRIPTION

The bones of the skeleton are currently in the process of being jacketed in plaster and carefully removed from the quarry. Field observations taken from exposed bones indicate that the skeleton is approximately 80-90% complete, and if mounted free standing may reach an estimated 40-45 feet in length, The standing area the feet occupy may be less than 16 feet long, hence, “Twinky” measures about half the length of an adult specimen from the same quarry.

Skeleton being excavated for jacketing

The skull is preserved and probably the lower jaws, as well, but a more accurate description must await lab preparation of these very delicate cranial elements, which were not disturbed while in the ground. Several tiny teeth were uncovered besides a mass of thin bone about 8 inches long located beneath a section of caudal vertebrae, which provides a high degree of probability that the entire cranium is preserved.

Atlas, axis and part of skull

Virtually complete sets of foot bones down to the claws, where also uncovered. The pelvic elements are also preserved semi-articulated. The limbs are preserved in near correct anatomical position. For example, the right hind limb (femur, tibia, fibula, and foot) is preserved in articulation folded immediately under the pelvis, in kind of squat position. The other limbs, including the complete scapulocoracoid and sternum sets, are similarly preserved in situ very close to the body, suggesting rapid burial after death.

Close up showing forelimbs including both scapulocoracoid, and sternum

Limb bones on pedestals ready for jacketing

Close up of dorsal vertebrae

The complete series of cervical, dorsal, sacral, and caudal vertebrae were found articulated without interruption. This important find allows, with certainty, identification of the exact number of elements in each vertebral group, thereby providing a template from which to compare other diplodocid fossils. This new information may also help to distinguish sexual dimorphism in Diplodocidae, possibly, by comparing the number of cervical vertebrae against the relative lengths and robustness in different individuals. Speculation, resulting from Dana Quarry's recent finds suggests the differences in cervical vertebrae may be gender related and not phylogenetic.

Interestingly, in the skeleton's death pose, the cervical vertebrae are flexed upward from the base where they meet the dorsal vertebrae, however, the big, elongated neck elements are positioned in straight alignment. In contrast, the preserved position of the caudal bones are arched over and around the upper part of the body, suggesting that the tail, in life, can bend up and move much more freely than the neck. Comparisons from two other skeleton examples with articulated cervical vertebrae ("Probrontodiplodocus" and "Sleeping Beauty") also from Dana Quarry, we can see that the anterior vertebrae are more flexible, presumably to enable the head to look about independently, despite the restricted movement that exists in the rest of the neck. In this manner, the head and neck may have functioned similarly as in living giraffes, in increasing the ability to see completely around the body. In "Probrontodiplodocus" the cervical vertebrae from 1-9, the neural arches are undivided, which provides more evidence supporting the functional forward movement of the neck. This condition is unique for Dana sauropods, and marks the most primitive condition known in Diplodocidae.

Caudal 1 –9, right to left

Caudal 9 – 13, right to left

Caudal 12 – 17, right to left

Caudal 16 – 20, right to left, fused

Caudal 20 – 24, right to left

Caudal 24 – 29, right to left

Caudal 28 – 33, right to left

Caudal 31 - 34, right to left

Together with the caudal vertebrae, a virtually continuous series of chevrons is preserved exhibiting exact placement together with a diversity of shapes along the tail not seen before. The most interesting are the transitional chevrons located between the single club-shaped ones in front and the characteristic double beam types behind. In these chevrons, the anteroposteriorly expanded distal processes are formed downward creating distinctive arches. This assortment of chevron shapes along the tail length is reminiscent of the condition seen in some mammalian groups that have powerful prehensile tails, as in anteaters for example. Another noteworthy feature lies in the presence of four fused mid caudal vertebrae, possibly numbers C16-20. Fused caudal vertebrae are a characteristic Diplodocid feature found in many but not all specimens. The fusion of the mid caudal vertebrae may have acted the same way a bullwhip employed from a man's arm responds by helping to transmit power and speed through the unique combination of rigidity and looseness of the tail. As far as the back as the turn of the last century, speculation concerning the fused caudal elements suggests that they may have acted to strengthen the tail when rearing into a tripod stance.

The partial axial skeleton of Diplodocus longus, from Como Bluff, housed at the American Museum (Osborn1899), and the only other comparable example, is in most details different by comparison, despite the similar overall appearance. In the AMNH specimen, there are no fused vertebrae, and transitional chevrons are not deeply arched. The whiplash section of the tail is not preserved and cannot be compared.

Towards the end of the "Twinky" tail, after the 32nd caudal, the neural spines in the whiplash section of vertebrae suddenly change into simple but robust freestanding processes with a distinctive backward hook. These spines are without zygapophyses, and seem to have developed to provide added weight and strength to better control the free action in the whiptail. These hooked shaped neural spines may have helped to create a serrated edged along the tail, enhancing the flesh cutting ability of the tail during its use. In their sandstone matrix, these whiplash vertebrae are noticeably preserved spaced apart, indicating that these elongated elements, may have been held together by a tough but flexible tissue. The ends of these vertebrae seem to be biconvex but matrix surrounding them prevents positive proof of this condition. Over a dozen whiptail vertebrae are present past the 32nd , but the exact number cannot be determined until complete preparation is completed. Thus, this extraordinary

functional morphology in the tail region of these dinosaurs supports the presence of a capability more sophisticated than the side swiping tail defensive behavior of a monitor lizard or crocodile. In life, "Twinky", with a tail designed to slash flesh, may have had the capability to strike at a target with deadly accuracy.

Another aspect of this specimen lies in the disproportionately large limbs in comparison to the axial skeleton, which is indicative of the relatively young age of this individual. The reconstructed skeleton may recall the ungainly appearance seen in puppies or in a pony. This observation is from bones exposed in the field, and cannot be confirmed in measurements until completed preparation allows.

SPECIES IDENTIFICATION

Twinky's overall osteological resemblance to other diplodocid specimens from the same quarry is great. For example, a distinct morphology shared in all these specimens is the lack of ventral sculpting of the mid caudal vertebrae, which is a diagnostic feature in this group of sauropods. Therefore, in the strict sense of the term, this sample of diplodocids cannot be identified as *Diplodocus.* The lack of this caudal feature, together with other primitive features seen in the cervical vertebrae explained above, suggests that these specimens may likely represent a new basal species allied to both *Diplodocus* and *Apatosaurus* - a "Probrontodiplodocus" if you will. This would not be an unreasonable possibility considering the older age determination of the Dana Quarry as being part of the lower Morrison Formation (Kimmeridgian, Late Jurassic)

DANA QUARRY

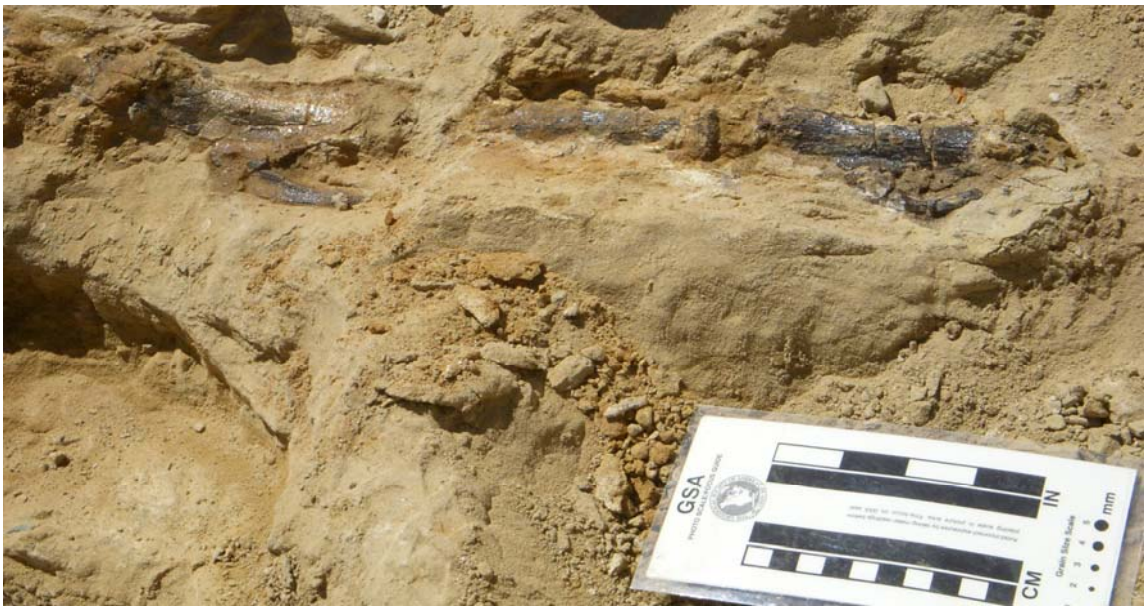
The Dana Quarry site is located at the western edge of the Bighorn Mountains near the town of Ten Sleep in Washakie County, Wyoming. This unique site was discovered more than 15 years ago by the present landowner, but its scope and importance went unappreciated until the summer of 2006, when the Dinosauria International, LLC team organized proper excavation and documentation. These recent excavations have revealed a spectacular Morrison Formation site, preserving an enormous multi-species death assemblage of dinosaurs.

The Dana Quarry appears to be situated within the lower part of the Morrison Formation. The fossil producing layers are approximately 20-30 feet above the Sundance Formation, with the contact of these two formations visible on the eastern slope of the site. On the ranch property, looking west from the quarry one can see conglomerate sandstone possible remnants of the Cloverly Formation sitting on the Morrison. Thus, the Morrison Formation at this locality appears to be sandwiched between the Cloverly above and the Sundance below. Unless an unconformity exists between the two formations, the Dana Quarry can be considered Lower Morrison in age.

The lower Morrison age determination may be significant, as localities producing older faunas are rare in the formation. Throughout most of its range, the Morrison Formation comprises mudstone, sandstone, siltstone and limestone and its layers are light grey, greenish gray, or red. However, at the Dana Quarry, the fossiliferous layers are comprised for the most part of soft sands that are predominately yellow-brown in color. These yellow layers preserve both plant and animal remains are in abundance possibly marking a unique depositional event. In these layers, gypsum inclusions are common together with lenses of grey mudstones both containing fossils.

Preliminary faunal comparisons support the stratigraphic position of the Dana Quarry as being older. The supporting evidence for an older time period lies in presence of two primitive dinosaur species of *Allosaurus* and *Hesperosurus.* In the *Allosaurus ("jimmadsoni*"), skeleton, the skull is characterized by a horizontal lower boarder of the jugal, manus claws less hooked and the general slenderness of the skeleton, in comparison to the more derived *Allosaurus fragilis*. Our stegosaur, *Hesperosaurus cf mjosi*, is known only from Lower Morrison localities. Additional supporting evidence lies in the primitive morphology of the brain case belonging to the *Apatosaurus*, "Einstein". In

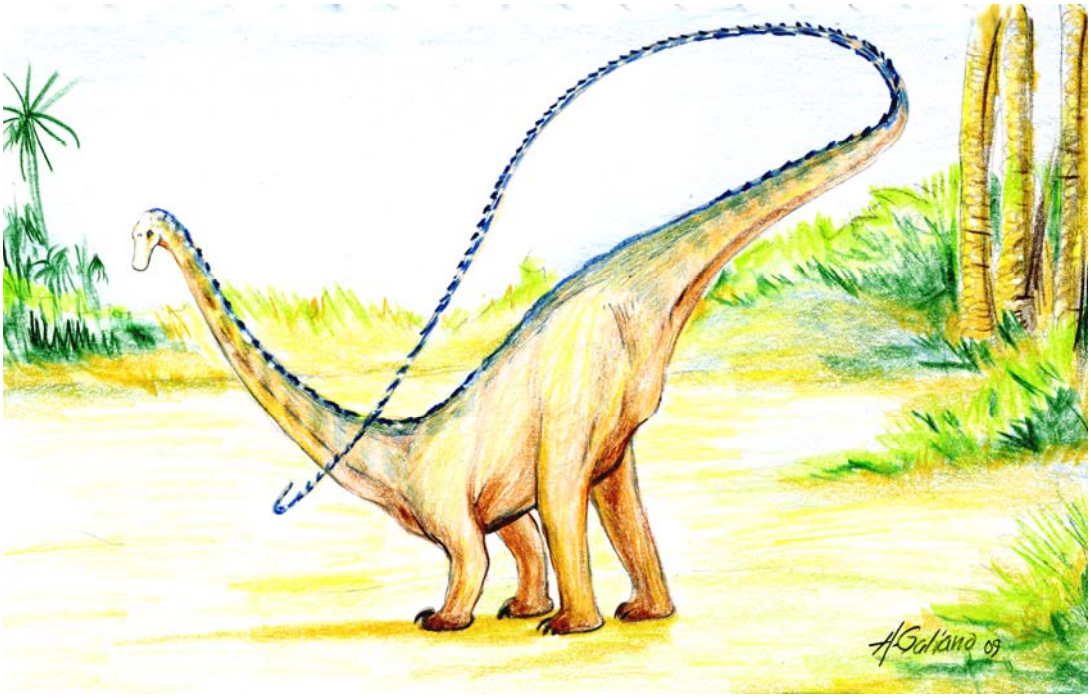
this specimen, the occipital condyle is proportionally smaller in comparison with other specimens attributed to Upper Morrison *Apatosaurus*. Dr. Robert T. Bakker (personnel communication) believes that the *Apatosaurus* skeleton originally from the Dana Quarry may possibly belong to *Eobrontosaurus*. These dinosaur three species are reported only from Lower Morrison Formation sites.



Caudal vertebrae 32 –34, displaying specialized neural spines and spaces in between

Caudal vertebrae 35–47, displaying whiptail bones lacking neural spines, brush bristles width two inches

Morrison Formation viewed looking north from Dana Quarry



Twinky life restoration