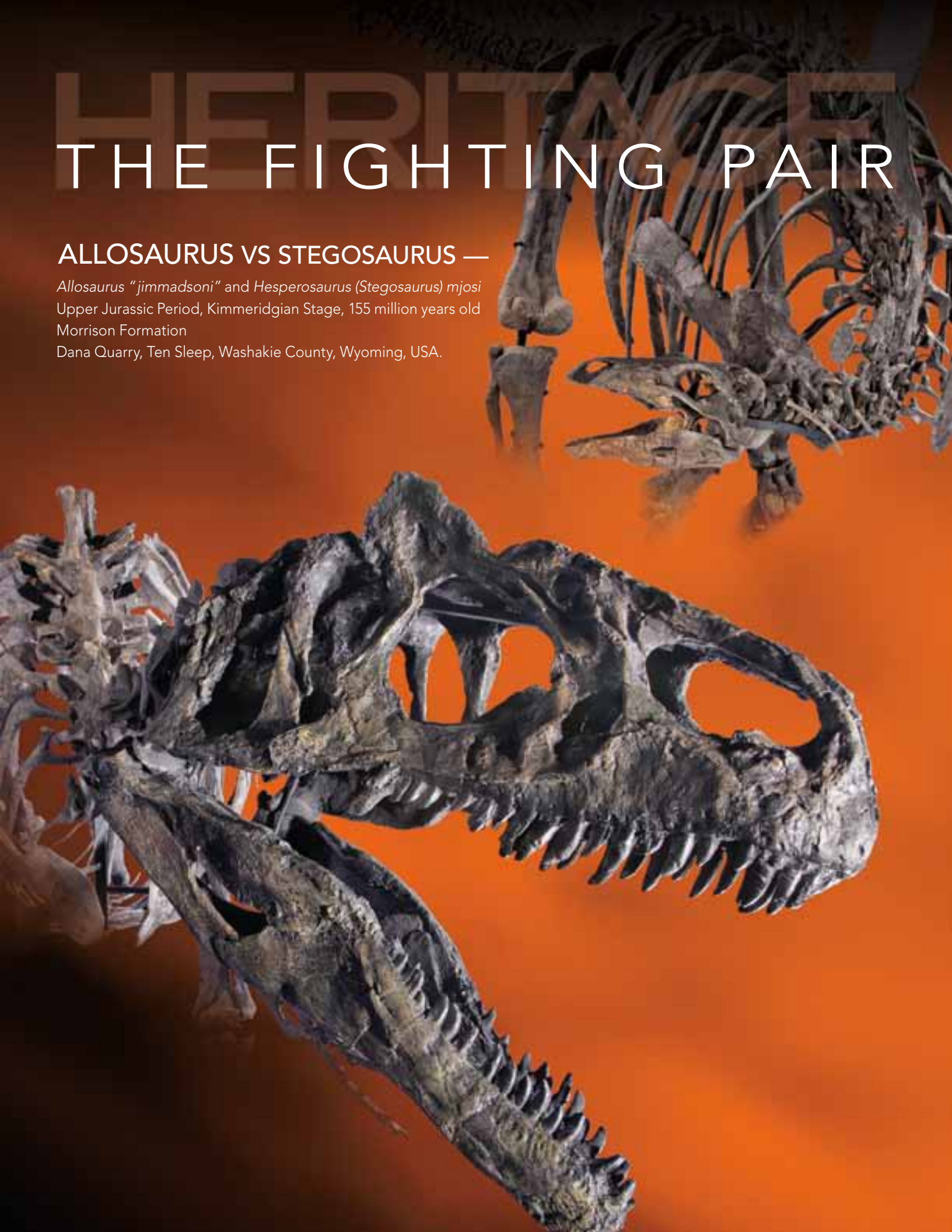
THE FIGHTING PAIR

ALLOSAURUS VS STEGOSAURUS —

Allosaurus "jimmadsoni" and *Hesperosaurus (Stegosaurus) mjosi*
Upper Jurassic Period, Kimmeridgian Stage, 155 million years old
Morrison Formation
Dana Quarry, Ten Sleep, Washakie County, Wyoming, USA.



HERITAGE

In the spring of 2007, at the newly-investigated Dana Quarry in the Morrison Formation of Wyoming, the team from Dinosauria International LLC made an exciting discovery: the beautifully preserved femur of the giant carnivorous Allosaur. As they kept digging, their excitement grew greater; next came toe bones, leg bones, ribs, vertebrae and finally a skull: complete, undistorted and, remarkably, with full dentition. It was an incredible find; one of the most classic dinosaurs, virtually complete, articulated and in beautiful condition. But that was not all. When the team got the field jackets back to the preparation lab, they discovered another leg bone beneath the Allosaurus skull… There was another dinosaur in the 150 million year-old rock. After more digging and more bones, they realize the enormity of their discovery; the Allosaurus apparently died in the midst of mortal combat with another iconic Jurassic dinosaur; the Stegosaurus.

The Allosaurus and Stegosaurus, deadly carnivore and armored herbivore, were suspected of having fought pitched battles across the savannahs of Upper Jurassic North America but never before had they been found together. Here at last was proof not only of their co-existence, but an actual preservation of their combat. Previously reported finds included a Stegosaurus neck plate with a U-shaped wound corresponding to the bite of an Allosaur, and an Allosaurus tail vertebrae with a puncture wound the exact shape of a Stegosaurus tail spike. The association was undeniable: the humerus of the Stegosaur was found almost inside the mouth of the Allosaur, and given their complete articulation, it is impossible not to imagine the two giants caught in a fight to the death. The Stegosaur was named "Fantasia" after a scene in the classic Disney film. The Allosaurus was named "Dracula" for its bristling mouthful of deadly teeth. This is a unique opportunity to own this unprecedented find: two incredibly well-preserved iconic dinosaurs identified as rare species of well-known genera and found in association in the oldest and least-explored stratigraphic zone of a famous and historically important American geologic formation.

THE ALLOSAURUS

The Official State Fossil of Utah, the Allosaurus was a large theropod carnosaur of the "bird-hipped" Saurischia order that flourished primarily in North America during the Upper Jurassic Period, 155-145 million years ago. Long recognized in popular culture, it bears the distinction of being one of the first dinosaurs to be depicted on the silver screen, the apex predator of the 1912 novel and 1925 cinema adaptation of Conan Doyle's *The Lost World*.

The Allosaurus possessed a large head on a short neck, a broad rib-cage creating a barrel chest, small three-fingered forelimbs, large powerful hind limbs with hoof-like feet, and a long heavy tail to act as a counter-balance. It averaged 28 feet in length and 2.5 tons in weight, with estimates putting the largest at up to 43 feet long. Its massive bulk was augmented with a mouth full of knife-like teeth, hand claws like daggers and foot claws like meat hooks, which it used to attack almost any kind of prey, from the giant sauropods to the more manageable ornithopods, and even other carnosaurs. Studies of the hind limbs suggest an Allosaur could reach speeds of 19 to 34 miles per hour, easily overtaking small prey. For oversized prey, such as the Diplodocus, the Allosaurus would have been a "flesh-grazer".

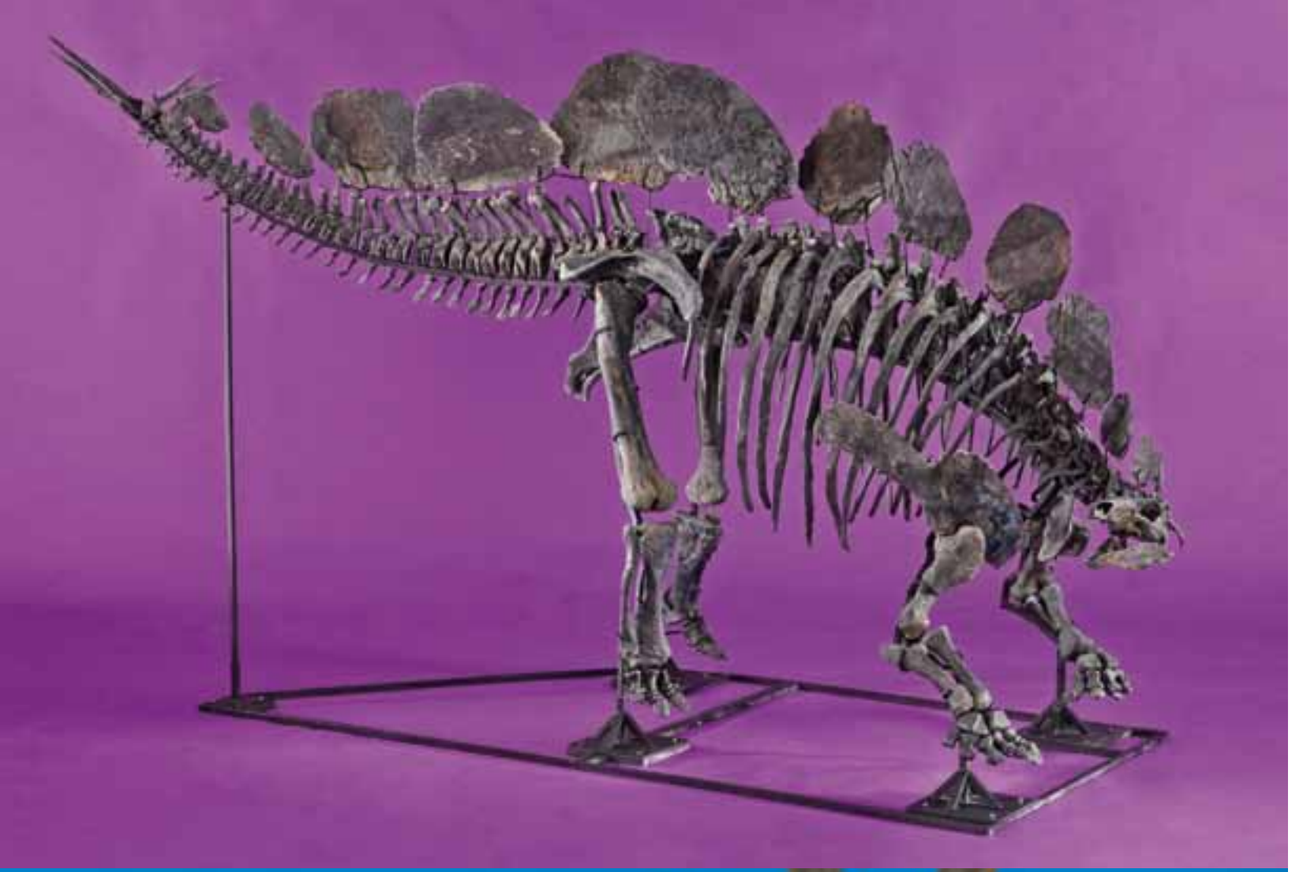
The skull itself had a distinctive appearance, with a notable pair of ridges along the top, terminating in horn-like bone ridge. The large skull shows the typical paring away of unnecessary bone-structure to lessen its overall weight, and a relatively thin roof to the brain-case that may have been an aid to thermo-regulation. Also advantageous are comparatively well-developed sinuses in the maxillae, indicating that Allosaurs had an advanced sense of smell compared to other therapods.

The first Allosaur remains were discovered in 1869 in Middle Park, Granby County, Colorado, during the notorious "Bone Wars" of the last quarter of the nineteenth century. The heated rivalry between American paleontologists Edward Drinker Cope of the Academy of Natural Sciences in Philadelphia, and Othniel Charles Marsh of the Peabody Museum of Natural History at Yale resulted in a great rush of dinosaur discoveries. Marsh first definitively described the genus in 1877, coining the name *Allosaurus fragilis*. The first part means "different" or "strange" lizard, for the fact that its spine was unusual compared to other known therapods at the time, with hollow spaces in the neck and anterior vertebrae – unusually "fragilis". Today the Allosaurus is known from approximately 60 specimens of almost all ages; seven species have been considered potentially valid since 1988, with ten further dubious. The type species is the *A. fragilis*, with further variants being the *A.tendagurensis, A.amplexus, A.atrox, A.europaeus* (not yet proposed), *A.maximus* (assigned to the separate genus *Saurophaganax*) and the as-yet not formally described *A.jimmadseni*, the rare primitive species to which "Dracula" has been assigned.

"Dracula", along with "Fantasia," was found in the spring of 2007. "Dracula" is a full grown Allosaurus measuring approximately 21 feet in length. According to Dr Robert T. Bakker, "Dracula" appears to belong to a relatively new species; the *Allosaurus jimmadseni*. The lower jugal border of the skull is horizontal, the manus claws less hooked and the skeleton generally more slender in comparison to the well-known *Allosaurus fragilis*. *A.jimmadseni* is proposed in an unpublished manuscript†, and is regarded as being an earlier version of the *A.fragilis*, which is known from only one previously documented example. Much has yet to be learnt about the species.

Of all the Allosaur fossils discovered, "Dracula" represents one of the very few with a fully articulated, undistorted skull*. Most Allosaurs are found with their skulls in fragments and loose piles; but "Dracula" was articulated, allowing a rare look for researchers into the exact position and orientation of Allosaur skull bones. Its full set of teeth is an almost unheard-of characteristic; not only do Allosaurs shed teeth during their lifetime, but usually teeth fall out of the jaw bone after death, making this is an extremely rare and significant instance of the complete dentary arrangement being preserved. This information is immensely useful to science; so important in fact that the skull was prepped in jacket and un-restored so that further study can be done on the skull in the future. A cast was carefully made from the original skull to use for the mounted skeleton; this way the scientific integrity of the actual skull remains undisturbed.

Given that the skull represents about 30% of a dinosaur's entire skeleton, "Dracula" is about 70-75% original bone, with the tail and several dorsal vertebrae being modeled reproductions. The skeleton is mounted in an attack position and the mount is designed to allow replacement of individual bones; work continues at the Dana Quarry so as new bones are unearthed, they can be reunited with their original skeleton. The original skull comes carefully packed in a crate to go along with the mounted skeleton.



THE STEGOSAURUS

The Stegosaurus is another iconic dinosaur; its distinctive appearance having made it a favorite in popular culture; appearing in everything from King Kong's opponent in the original screen version of 1933 to Disney's 1940 *Fantasia*. The first Stegosaurus remains were collected by Othniel Charles Marsh during the Bone Wars in 1877, from the northern Morrison Formation in Colorado. Ornithischian (bird-hipped) dinosaurs, are members of the infraorder Stegosauria, family Stegosauridae, and thrived across North America during the Upper Jurassic, 155-145 million years ago. They are known from at least three species, *S.stenops, S. armatus* and *S.longispinus*, of which over 80 specimens have been collected from the Morrison Formation. The present specimen has been identified as the *Hesperosaurus mjosi* ("western lizard"), a mysterious genus described in 2001 by noted paleontologist Kenneth Carpenter from a single almost complete specimen found in stratigraphic zone 1 of the Morrison Formation in Wyoming. It was distinguished from the Stegosaurus by having shorter but longer plates on its back, and a shorter, broader skull.

The name Stegosaurus is derived from "roof lizard" in Greek, as assigned by Marsh, so chosen for the plate-like osteoderms; the alternating plates that lined its back and tail. The purpose of the plates remains unclear; they are not well placed for defense but could possibly have been used for thermoregulation, or just for decoration. More easily identified is the function of the four horizontal spikes that graced the Stegosaur's tail; these spikes could measure up to 3 feet long, and was certainly used as a weapon to defend against predators. The brain of the Stegosaur was quite small; cast of the cavity taken by Marsh indicates a brain weight of around 2.8oz and a size equivalent to that of a dog.

The Stegosaurs were herbivores; tracks in the Morrison Formation indicating that they lived in multi-age herds. It is posited that they were low-level browsers, feeding on bushes and fruit, and flora such as mosses, ferns, horsetails, cycads and conifers. Based on their jaw structures, they had limited chewing capacity; therefore they would swallow gastroliths, stones that sat in the stomach to aid digestion.

"Fantasia" appears to belong to a more primitive genus *Hersperosaurus mjosi*. As with the *A.jimmadseni*, only one other example of the *H.mjosi* has been documented, a partial skeleton with cranium. "Fantasia" boasts an exceptional skull, completely undistorted. The primitive nature of "Fantasia" is scientifically important to the history and evolution of Stegosaurs. Measuring 18 feet in length and standing over 8 feet tall, "Fantasia" is 75-80% complete and mounted together with a few elements of another skeleton of equal size and quality. The skeleton is accurately mounted in the same manner as the well-known Stegosaurus composite at the American Museum of Natural History.

THE MORRISON FORMATION

The Morrison Formation is the most abundant source of dinosaur fossils in North America. A sedimentary rock unit, its exposures are most commonly seen in the Western States of New Mexico, Colorado, Utah and Wyoming, with further outcrops in surrounding states and even up to Canada. Throughout most of its range, it comprises mudstone, sandstone, siltstone and limestone, with easily distinguished layers in shades of light grey, greenish gray, or red. It covers an area of 1.5 million square miles, although over 75% is inaccessible beneath prairies, and a large proportion of the remainder was destroyed by erosion as the Rocky Mountains rose in the west.

The formation is dated to the late Oxfordian to early Tithonian stages of the Upper Jurassic Period, 156.3-146.8 million years ago, and is divided into five stratigraphic zones, with zone 1 being the oldest. The southern part of the area was semi-arid, a desert with dunes, whilst the northern part bordered the Sundance Sea (an extension of the Arctic Ocean) and was wetter and more swampy. In between there were floodplains, conifer forests and fern savannahs with sparse trees.

The Morrison Formation was named in 1877 after Morrison, Colorado, and was to become the center of the notorious Bone Wars. The abundance and variety of paleobiota is remarkable, from amphibians, to arthropods,to fish, mammals, lizards and pterosaurs. *sauropods Apatosaurus, Brachiosaurus, Camarasaurus*, and *Diplodocus*, and the *ornithischians Camptosaurus, Dryosaurus*, and *Stegosaurus*.

THE DANA QUARRY

Roughly 195 miles east of Yellowstone National Park, the Dana Quarry is located on the western edge of the Bighorn Mountains near the town of Ten Sleep in Washakie County, Wyoming. Although a relatively newly investigated site, the Dana Quarry is already famous for outstandingly well-preserved articulated dinosaurs. Discovered more than 15 years ago, the scope and importance of the site was not appreciated until Dinosauria International LLC made their first investigations in 2006, with professional excavation and documentation. Since then, the quantity, variety and quality of specimens unearthed from an important and underrepresented period of American paleontology have demonstrated that the Dana Quarry is amongst the most significant fossil sites in North America.

Unlike the rest of the Morrison Formation, the fossil-rich layers of the Dana Quarry are predominantly a yellow-ochre sandstone. These yellowish layers preserve both plant and animal remains in abundance. The fossiliferous strata lie approximately 20-30 feet above the Sundance Formation, with the boundary between the two units visible on the eastern slope of the site. Looking west from the quarry, one can see conglomerate sandstone, remnants of the Cloverly Formation above the Morrison. Thus, the Dana Quarry appears to be situated within the lower, older, part of the Morrison Formation, stratigraphic zone 1, a zone in which dinosaur fossils have previously been scarce.

Current speculation suggests that the site may have been a natural trap, an oxbow river with little current which, during a time of drought, became a muddy death trap. As with the famed tar pits of the Rancho La Brea Formation, herbivorous species would have come to drink, and the unlucky were caught in the sucking mud. Attracted by panicked death cries, predators arrived for some easy pickings, only to find themselves similarly entrapped, and the result is the rare record of an enormous multi-species prey/predator chain reaction event.

In the relatively small quarry, over 15 individual dinosaur skeletons have already been recovered and documented in an attempt to reconstruct this Late Jurassic graveyard. The exquisite quality of their preservation and the completeness of their remains are outstanding, as is the variety of species: *Apatosaurus, Diplodocus, Camarasaurus, Allosaurus, Ornitholestes, Coelurus, Torvosaurus, Ceratosaurus, Othnielosaurus, Camptosaurus,* and *Hesperosaurus*. The quarry is also a rich source of floral fossils, having yielded remains of many species of extinct plants including horsetails, ferns, cycads, and conifers. A notable absence, however, are the early mammals found elsewhere in the Morrison Formation; reinforcing the impression that the quarry represents the earliest portion of the Formation. The primitive nature of several of the dinosaur species, including the Allosaurus and Stegosaurus/Hesperosaurus, further bears this out. It is a relatively new time period for North American Jurassic fossils and hugely under-investigated; the Dana Quarry, with specimens of such quality and completeness, and such a remarkable diversity of the paleobiota, offers incredibly exciting new prospects for osteological and paleoecological research. The surface has only been scraped; the potential is enormous.

THE IMPORTANCE OF THE PAIR

This is the first time that these two iconic dinosaurs of the Jurassic have been found together, in remarkable condition, and are available for acquisition with a remarkable amount of data to offer. Their early age give insight into the development and evolution of Jurassic dinosaurs in North America and their association gives them historic scientific significance. Both skeletons contain a majority of original bone and are prepared professionally with minimal restoration; the mounts are also professionally made and the bones are placed in osteologically correct position.

An important feature of this pair is that they were professionally collected and documented with full locality and stratigraphic data; the locality information for the fossils originating from this site is: T. 48N., R. 89W., Sec.6, NW1/4 SW1/4, Ten Sleep, Washakie County, Wyoming – GPS: N44° 03.078 W 107° 27.503. The greatest care has been taken from the very start of the process to excavate, preserve and present the bones with their scientific value and significance uncompromised. This is a rare opportunity to own a unique and prestigious discovery.

For more information, contact:
David Herskowitz
Director of Natural History
DavidH@HA.com
214-409-1610
800-872-6467 ext. 1610

* The following Allosaurus skulls are mostly complete and were found articulated: UUVP 6000, Carnegie Quarry Dinosaur National Monument; YPM 1894, Como Bluff; BYU 571-8901, Hinkle Quarry; BYU 9488, Easter Quarry; DINO 11541, DNM-116 Quarry; MOR 693 "Big Al", Howe Quarry; BYU 9466, San Rafael Swell area, Utah; BYU 8901, skull with much of skeleton from Brushy Basin Member; skull with skeleton in the Paleontological Museum in Naples/Turin from San Rafael Swell area, Utah; UMNH VP C481, Meilyn Quarry juvenile (disarticulated in place at the end of the neck); and "Ebeneezer", God's Allosaur, from Dinosaur Colorado, now in Crystal River, FL

The following skulls are mostly complete but disarticulated: USNM 4734 type, Marsh's Felch Quarry 1; SMA 0005 "Big Al 2", Howe Quarry, a fairly complete skull with skeleton mounted at the Sauriermuseum, Aathal, Switzerland; AMNH 5753, Como Bluff; AMNH 666, Como Bluff; AMNH 600, Como Bluff, SC 1, Sheridan College; "yellow skull" from CLDQ; and The Canyon City specimen at the Smithsonian.

† Chure, Daniel J., "A new species of Allosaurus from the Morrison Formation of Dinosaur National Monument (Utah–Colorado) and a revision of the theropod family Allosauridae" (2000), PhD dissertation, Columbia University.