The concrete *Diplodocus* of Vernal

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**Abstract**

XXX to follow

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Table of Contents

[Introduction 1](#__RefHeading___Toc3531_2542618767)

[Nomenclature 2](#__RefHeading___Toc943_1155462304)

[Institutional abbreviations 2](#__RefHeading___Toc5349_68767826)

[History of the concrete *Diplodocus* 2](#__RefHeading___Toc1946_2786159041)

[The original Carnegie *Diplodocus* 2](#__RefHeading___Toc1948_2786159041)

[The first casts of the Carnegie *Diplodocus* 3](#__RefHeading___Toc1950_2786159041)

[The Field House Museum in Vernal 3](#__RefHeading___Toc947_1155462304)

[The concrete cast in Vernal 4](#__RefHeading___Toc416_3962850034)

[The fate of the original molds 5](#__RefHeading___Toc430_3962850034)

[The lightweight cast in Vernal 6](#__RefHeading___Toc949_1155462304)

[New casts made from molds of the concrete *Diplodocus* 7](#__RefHeading___Toc418_3962850034)

[The fate of the concrete *Diplodocus* 7](#__RefHeading___Toc953_1155462304)

[Discussion 8](#__RefHeading___Toc3401_68767826)

[Acknowledgements 8](#__RefHeading___Toc3529_2542618767)

[References 8](#__RefHeading___Toc3405_68767826)

[Figure Captions 10](#__RefHeading___Toc3407_68767826)

# Introduction

*Diplodocus* is a sauropod dinosaur from the Late Jurassic of North America, found in the extensive Morrison Formation of the western states. Although larger and more complete sauropods are now known, *Diplodocus* was the first giant dinosaur known from a substantially complete skeleton: the Carnegie Museum’s iconic specimen CM 84 (Figure A). As summarised in Taylor et al. (in prep, a) and expounded in detail by Nieuwland (2019), casts of this important specimen were sent all around the globe, and as a result this individual became — and remains — the single best-known dinosaur in the world.

Among the numerous *Diplodocus* casts that have been mounted, many have been made in plaster, including all the oldest ones; and many have been made in modern lightweight materials such as water-expanded polyester (WEP). But one stands alone, having been cast in concrete by the Utah Field House museum in Vernal.

In this paper, we will briefly summarise the history of the original Carnegie *Diplodocus*, discuss how the concrete cast came to be, and consider its legacy.

## Nomenclature

A distinction is made between molds and casts. A mold is a negative structure made from an original specimen (or, less commonly, a cast), in which the spaces inside the mold match the shapes of the original specimen. A cast is a positive structure, a copy made of a specimen made by filling a mold, and its shape matches that of the original specimen.

Vertebrae are designated as follows, for a vertebra at position *n* in a part of the spinal column: cervical vertebrae C*n*, dorsal vertebrae D*n*, and caudal vertebrae Ca*n*.

## Institutional abbreviations

* AMNH — American Museum of Natural History, New York, New York, USA.
* CM — Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA.
* **UNUSED** HMNS — Houston Museum of Nature and Science, Houston, Texas, USA.
* **UNUSED** MB — Museum für Naturkunde Berlin, Berlin, Germany; specimen numbers for fossil reptiles take the form MB.R.*nnnn*.
* **UNUSED** USNM – United States National Museum, Washington DC, USA.
* **UNUSED** YPM — Yale Peabody Museum, New Haven, Connecticut, USA.

# History of the concrete *Diplodocus*

## The original Carnegie *Diplodocus*

As related in Taylor et al. (in prep, a), the industrialist and philanthropist Andrew Carnegie was inspired by a newspaper article in the late 1800s to ask the director of the museum that bears his name to obtain a giant dinosaur skeleton for exhibit. In July 1901, an expedition from the museum found a largely complete specimen of the sauropod *Diplodocus*, which when excavated and prepared was given the specimen number CM 84 and described in Hatcher’s (1901) monograph as the new species *Diplodocus carnegii*. In 1907, this specimen was mounted in the new dinosaur hall of the Carnegie Museum, its missing portions filled in with bones from a second *Diplodocus carnegii* specimen CM 94, and casts and sculptures based on other closely related specimens, some of them from other museums.

This mounted skeleton quickly became the icon of the Carnegie Museum, and has remained so up to the present, even after the addition to the dinosaur hall of the even larger apatosaurine mounted skeleton CM 3018 which would subsequently be designated the holotype of the new species *Apatosaurus louisae* (Gilmore 1936). The *Diplodocus* skeleton, known by the rather inelegant nickname “Dippy”, has been moved and modified several times in the years since its initial mounting, most recently in the 2005–2007 major redesign of the Carnegie Museum. It presently co-stars with CM 3018 in the new Jurassic Hall.

## The first casts of the Carnegie *Diplodocus*

Well before the mounting of the real bones of CM 84, Carnegie was asked by King Edward VII of England for a copy of the skeleton to be displayed in the British Museum (Natural History). Carnegie optimistically hoped to put an end to war by encouraging arbitration instead, and to this end was always keen to gain influence with heads of state. He therefore enthusiastically agreed to the King’s request and instructed museum director William. J. Holland to create a replica.

Holland oversaw the creation of a set of plaster molds corresponding to the bones of CM 84 and the other bones that were to be included in the real-bone mount a few years later. Some differences exist between the molds and the real skeleton (see Taylor et al. in prep., a for details) but the molds corresponded closely to the original skeleton. These molds were used to create not just the cast skeleton requested by King Edward VII, but four further casts. After the British Museum unveiled its mounted cast to great fanfare on 12th May 1905, and after the original bones were mounted at the Carnegie Museum in 1907, Carnegie went on to gift the other four casts to Kaiser Wilhelm II of Germany, Président Armand Fallières of France, Emperor Franz Joseph of Austria and King Victor Emmanuel III of Italy in 1908 and 1909. As with the London mount, Holland and his chief preparator Arthur S. Coggleshall travelled to each recipient country to supervise the mounting of the casts.

Buoyed by success of his donation program, Carnegie authorised the creation of five further casts from the same molds, destined to be donated to other heads of state. Between 1910 and 1913 three of these were given to Tsar Nicholas II of Russia, President Roque Sáenz Peña Lahitte of Argentina and King Alfonso XIII of Spain. But the outbreak of the Great War in 1914 put an end to Carnegie’s dream of arbitration replacing warfare, and left him a broken man. When he died in 1919, not only had the two remaining skeletons not been donated, the museum was left impoverished. Only years later, with the aid of funds from Carnegie’s widow Louise, would these last two casts be sent to Mexico City (1930) and Munich (1934) — the latter never even being mounted.

The molds, having last been used in the 1910s, then lay forgotten in the basement of the Carnegie Museum for more than 40 years (Untermann 1959:364).

## The Field House Museum in Vernal

As recounted by Untermann and Untermann (1970), the genesis of the Field House lay with Arthur G. Nord, supervisor of the Ashley National Forest, who in the 1930s became concerned that the mineral and fossil wealth of the Vernal area was being shipped to museums outside the locality. The Vernal Lions Club first proposed the creation of a museum in Vernal at its meeting of 9 September 1934, returning to the idea on 6 September 1943 (XXX [https://newspapers.lib.utah.edu/details?id=21656641&page=2&q=Dippy&sort=date\_tdt+asc%2Cparent\_i+asc%2Cpage\_i+asc&facet\_paper=%22Vernal+Express%22](https://newspapers.lib.utah.edu/details?id=21656641&page=2&q=Dippy&sort=date_tdt+asc%2Cparent_i+asc%2Cpage_i+asc&facet_paper="Vernal+Express")). A museum committee was formed to advocate for a local museum. A senate bill approving the museum was passed in 1945, and the next year Governor Herbert B. Maw made $200,000 available to construct the museum building. G. Ernest Untermann was appointed director of the museum project, and was assisted by his wife Billie, a capable scientist and administrator in her own right. Based on drawings created by the Untermanns, the Salt Lake City architect Miles E. Miller drew up the plans, and the building was erected by Dorland Construction Company. The work was begun on 16 October 1947 and completed on 1 July 1948, and the building was dedicated on 29 October 1948 by Governor Maw.

## The concrete cast in Vernal

The head of the Carnegie Museum’s department of vertebrate paleontology in the early 1950s was J. LeRoy Kay, a native of Vernal. In 1952 (not 1955 as stated by Untermann and Untermann 1970), he gifted the original plaster molds of the Carnegie *Diplodocus* to the Field House (Untermann 1952, 1959), on the condition that the Field House would arrange transportation. As the molds weighed several tons (Untermann 1952) this was no small undertaking. The Utah Lions Club provided the necessary $1000 payment, and local trucker Grant Southam used his own equipment to transport the molds. They arrived on or shortly before 7 August (Untermann 1952) (Figure B). However, having already been used to create ten casts, they were by this time “deteriorating” (Gangewere 1999:17), “almost unusable” (Nieuwland 2019:251) and “in pretty bad shape” (Ken Carpenter, pers. comm. 2022).

Curiously, the poor condition of the molds is not discussed in Untermann’s (1959) otherwise comprehensive account of the creation of Vernal’s cast. He recounts that the molds were dirty with Pittsburgh soot, requiring a steam bath, and that some repairs were necessary for molds that were actually broken, but the erosion and decay arising from ten prior castings are not mentioned.

Since the mounted skeleton’s 76-foot length was far too long for the museum’s 50-foot exhibit halls, plans were made to situate it outside the museum. Wind, rain and extreme temperatures — the Vernal climate ranges from –40˚F to 100˚F (–40˚C to 38˚C) — required a more robust casting material was required than the usual plaster. After some experimentation with different materials, the team settled on a mix of one part cement to three parts Aggra-lite (a lightweight aggregate made of volcanic pumice). A complete cast would consist of about 600 — many more than the number of bones, as the complex vertebrae were made from multiple pieces. About 100 of these had been completed, when Otto Buehner, president of Salt Lake City’s Otto Buehner Concrete Products Company, visited the museum, became interested in the casting, and expressed doubts about the use of Aggra-lite. Further experimentation, aided by Buehner’s experienced workers, resulted in the selection of new mixture, one part cement to three parts aragonite (the high pressure polymorph of calcium carbonate). Most of the pieces were cast in this material by Grant Merrell, the museum’s preparator, at the Otto Buehner facilities, with the more intricate parts completed at the museum. Reinforcing wire and rods were used where necessary, and the completed bones were coated in fibreglass to protect them from the elements. (The Buehner Company benefitted from its involvement with the casting, as they discovered in the course of the process that fibreglass made a better and cheaper adhesive than they had previously been using to repair Italian marble when it was broken in transit. The Field House also adopted fibreglass as its bonding agent of choice after positive experiences with the concrete cast.)

The result of all this work was nearly 600 concrete elements which then had to be assembled into a skeleton. First, the individual bones were assembled from their pieces — work done by the Untermanns and Merrell. Identifying numbers on the molds had mostly faded with age, so this had to be done from anatomical principles. Pieces were fastened together with steel rods and bonded by fibreglass. The assembled bones were then laid out in the workshop to verify that everything was present and correct (Figure D; Untermann 1959:figures 1, 2).

With this done, the work moved outside. On a concrete base, and surrounded by a chain-link fence — the latter provided by the same Vernal Lions Club that had paid for the molds to be transported — the cast bones were assembled: sacrum and pelvis first (Figure E.A), then hind limbs, dorsal vertebrae, cervical and caudal vertebrae and skull (Figure E.B), then finally the front limbs and ribs. The skull was mounted 21 feet (6.4 m) above the ground at the end of a somewhat elevated neck. The whole skeleton was not only supported on a steel scaffolding, but also guyed by thinner rods, enabling it to withstand 70 mph winds that uprooted nearby trees (Untermann 1959:367–368).

The completed outdoor cast was dedicated on 6 June, 1957 (Untermann and Untermann 1970). The work had taken about a year and a half, from early 1956, and cost only $10,000 in total — almost all of it in salary. The cast stood for 32 years (Figure F). It was repainted on 22 June 1967 (Figure G) in what was likely an annual event (Anonymous 1967).

## The fate of the original molds

So far as we have been able to determine, the casting of the concrete *Diplodocus* of Vernal was the last time the Carnegie Museum’s original molds are used. However, that was not Untermann’s intention. In his 1959 account, he wrote (p368–369):

Several museums in the United States and from lands as distant as Japan and Italy have expressed a desire to acquire the molds and cast a *Diplodocus* of their own from either plaster or some of the newer synthetics. To date no museum has apparently been able to make satisfactory arrangement for the acquisition of the molds and the casting of a skeleton. We still have the molds in Vernal, and any museum, anywhere, is welcome to them just for hauling them off. […] The Diplodocus on the lawn of the Utah Field House is the eleventh replica to be cast from the molds […] Does anyone wish to cast the twelfth?

Ken Carpenter (pers. comm., 2022) recalls that in the 1950s or 1960s, the Field House posted a notice in the SVP (Society of Vertebrate Paleontology) news bulletin offering the plaster molds to whoever wanted them. XXX track this down: Andy Farke may have copies. From here, though, the story grows uncertain and contradictory.

Sassaman (1988) reported that “the molds finally fell apart because of old age soon after it [the concrete *Diplodocus*] was made”. However, Ilja Niewland (pers. comm., 2022) reports that “The original moulds were thrown away somewhere during the 1960s (nobody at the [Carnegie Museum] could be more specific than that)”. Most promisingly, a report in the *Vernal Express* newspaper (Anonymous 1960; Figure H; see also Carr and Hansen 2005) says that in the middle of July 1960, the molds were shipped to the Rocky Mount Children’s Museum (now the Rocky Mount Imperial Center, Children’s Museum & Science Centre) in North Carolina, with the intention that they would be used to create a twelfth cast which would be mounted outside the museum building next to the Tar River in Rocky Mount’s Sunset Park. Hurricane Floyd devastated Rocky Mount in 1999, flooding from the River Tar destroying the original Children's Museum along with all its exhibits and records (Leigh White, pers. comm., 2022), so no records survive of the molds’ arrival and subsequent use. The Children’s Museum was re-established at the newly build Imperial Centre, where it still resides, but no trace exists of their outdoor *Diplodocus* — if it was ever created. XXX find out more.

## The lightweight cast in Vernal

During the late 1980s, museum staff decided they wanted a new, lightweight cast of *Diplodocus* to mount indoors. As noted above, the 50-foot-long galleries could not accommodate a 76-foot-long mount at its full length, but it was decided to curve the tail to enable it to fit. That is course had been an option in 1957 when the concrete cast was created, but perhaps Untermann, then the museum director, had wanted the tail laid straight out. Untermann had died in 1975, two years after his wife Billie (Lewis 1977).

XXX expand this bit when Steve sends documents.1988, January: plans are made to have a lightweight indoor replica of the Field House concrete cast created by the Las Vegas Museum, but these plans fall through.

According to the records here, molds/replicas were to be made for/by the Las Vegas Museum of Natural History (before DINOLABs got involved), but apparently never did. We have a few letters dated in Jan 1988 and early spring 1989 about this. There seems to be some conflicting information between the Vegas Museum agreement and letters. According to an unassigned agreement, the Vegas Museum (through some unnamed contractor) was supposed to disassemble the cement Dippy, transport it to Las Vegas and make two replicas. One for their museum and one for us, and return the original cement version and new molds to the Utah Field House. A letter dated Jan 28, 1989 from Willima Murdock Jr., then Director of the Vegas Museum, says the opposite. We would get a replica and they keep cement Dippy and new molds, with permission to cast more. In April 1989 Jim Madsen at DINOLABS was contacted to help with the plans of making a replica since Vegas dropped.

1989, April: Jim Madsen of Dinolab is contacted to make new plans for creating a replica from the concrete cast

1989, June 28: Dippy is gone. [https://newspapers.lib.utah.edu/details?id=22643733&page=3&q=Dippy&sort=date\_tdt+asc%2Cparent\_i+asc%2Cpage\_i+asc&facet\_paper=%22Vernal+Express%22](https://newspapers.lib.utah.edu/details?id=22643733&page=3&q=Dippy&sort=date_tdt+asc%2Cparent_i+asc%2Cpage_i+asc&facet_paper="Vernal+Express")

1989, June 30 onwards: Dinolab repaired the deteriorated concrete cast, stabilizing, restoring and sealing the bones. Jim Madsen of Dinolab made new molds from the repaired concrete Diplodocus, using them to create a new lightweight indoor Diplodocus cast for the Field House, from WEP (water-expanded polyester), and reserving the right to make up to 20 additional casts (Madsen et al. 1989). 1991, not later than June 30: Dinolab is contracted to deliver the indoor mount (Madsen et al. 1989).

1991, June 26: the new cast is delivered to Vernal. [https://newspapers.lib.utah.edu/details?id=22646163&page=3&q=Dippy&sort=date\_tdt+asc%2Cparent\_i+asc%2Cpage\_i+asc&facet\_paper=%22Vernal+Express%22](https://newspapers.lib.utah.edu/details?id=22646163&page=3&q=Dippy&sort=date_tdt+asc%2Cparent_i+asc%2Cpage_i+asc&facet_paper="Vernal+Express"). The concrete skeleton “remains in a back room in the fieldhouse. It cannot be reassembled because when it was taken apart linking material had to be cut”. The new cast was expected to be assembled that winter.

1993, June 23: the new cast is in the process of being reassembled with its head and neck looming over the admission counter (Figure C). [https://newspapers.lib.utah.edu/details?id=22648688&page=3&q=Dippy&sort=date\_tdt+asc%2Cparent\_i+asc%2Cpage\_i+asc&facet\_paper=%22Vernal+Express%22](https://newspapers.lib.utah.edu/details?id=22648688&page=3&q=Dippy&sort=date_tdt+asc%2Cparent_i+asc%2Cpage_i+asc&facet_paper="Vernal+Express")

1994, week of June 15: the new cast is finally complete and unveiled. “He was pieced together by maintenance employee, Danny Anderson, who worked on him over a two year period only as time allowed.”

## New casts made from molds of the concrete *Diplodocus*

XXX to do

Some time subsequent to 1989: Jack McIntosh arranges a deal between Dinolab and RCI whereby the Dinolab creates casts of the Diplodocus elements needed to make up the missing part of the AMNH *Barosaurus* mount. See Gordy (1991), Norell et al. (1991), Dingus (1996:20–29), Taylor et al (in prep, b).

Subsequent years: further casts are made from the Dinolab molds, including one in the Las Vegas Natural History Museum and one in the Houston Natural History Museum.

“That opened up the possibility of a whole slew of further copies of this particular copy, which was immediately exploited by the Las Vegas Natural History Museum. One of these has been placed in the Las Vegas Natural History Museum” (Nieuwland 2010:68), which had originally been slated to create the new molds.

## The fate of the concrete *Diplodocus*

XXX to do

The old Dippy was never remounted by us after it was taken down.

In March 2000, when Steve Sroka began working at the Field House, the concrete cast was stored in the building crawl space.

May 22, 2004: The Field House moves to a new building, and the WEP cast is remounted in the entry hall. The concrete cast was left behind.

2012: The collections are moved from the old Field House building to the new one, but there is no space for the concrete cast.

2013: The concrete cast is sent to Utah State University Eastern Prehistoric Museum on effectively permanent loan, and to be repaired. It was intended to be mounted outside a new museum in Price, but this museum was never built and the cast remains in storage on the Utah State University Eastern campus.

2019: Dinolab storage in Ogden, Utah, is scheduled for demolition. The Diplodocus molds that were taken from the concrete cast are moved to RCI, where they are kept in storage: some in good condition, some in rough shape. These are probably the only Carnegie Diplodocus molds in the world.

“After the tour, in all likelihood the plaster dinosaur will meet an inglorious end in the basement of the museum; meanwhile, there has been talk of a more weather-resistant cast gracing the garden in front of the museum. And yes, that would mean that in this case, a cast is to be recast. What that means for “authenticity” or “relevance” is anybody’s guess.” (Nieuwland 2019:4).

# Discussion

XXX To do. Photographs of the concrete *Diplodocus* can be found at the J. Willard Marriott Digital Library of the University of Utah: <https://collections.lib.utah.edu/>

1. XXX To do. It's interesting, as I work on this, how sad the endings of various things are. The original Carnegie molds that were lost or destroyed in the 1960s; the Sunset Park *Diplodocus* that either never existed or was destroyed by Hurricane Floyd; the concrete *Diplodocus* that was supposed to be repaired by Dinolab but was never remounted; the molds that were made from the concrete casts sitting unloved in the Dinolab building until it was torn down, and now lurking the RCI's storage. I suppose most endings are sad, but the project definitely has a melancholy feel.

# Acknowledgements

XXX To do

Ken Carpenter

John Foster

Ilja Niewland

Elaine Carr, Uintah County Regional History Center

Leigh White, Rocky Mount Children’s Museum, North Carolina XXX get permission

More to follow.

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XXX Many of these are unused and should be removed.

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# Figure Captions

**Figure A.** The *Diplodocus carnegii* holotype CM 84 as it is today: the original fossil material mounted in the public gallery of the Carnegie Museum. Skeleton in left anterolateral view, with *Homo sapiens* Mathew J. Wedel for scale. Photograph by Michael P. Taylor.

**Figure B.** The original *Diplodocus* molds created by the Carnegie Museum, shown in the Utah Field House some time between 1953 and 1955. In the background to the left is the mold for the sacrum and coalesced ilia, seen in right ventrolateral view with anterior to the top. In the middle of the foreground is the mold for a posterior cervical vertebra in ventral view with anterior to the lower left. The molds closely follow the shapes of the bones they were modelled from, but are noticeably bulkier. From <https://collections.lib.utah.edu/details?id=1212242&q=diplodocus>

**Figure C.** The second-generation lightweight *Diplodocus* cast as originally mounted at the old Field House building between 1993 and 2006. **A.** Right anterolateral view, showing the head and neck projecting above the admission counter; **B.** Left posterolateral view, emphasizing the curvature of the elevated tail necessary to fit the 76-foot skeleton into the 50-foot exhibit hall. Photographs taken in May 1999 by Chet Gottfried, using a Pentax LX camera with a 17mm rectilinear fisheye lens. Used by kind permission.

**Figure D.** Field House Museum directory G. Ernest Untermann (left), and his wife Billie Untermann (right), grouting the cast dorsal vertebrae of the Field House’s concrete *Diplodocus*. 24 January 1957. <https://collections.lib.utah.edu/details?id=1086940&page=2&q=diplodocus>

**Figure E.** Assembly of the outdoor concrete *Diplodocus* at the Utah Field Museum in 1957. **A.** In right posterolateral view. The sacrum and fused ilia having been mounted on the main support to begin the process, the hindlimbs, last four dorsal vertebrae and first caudal have now been added. <https://collections.lib.utah.edu/details?id=1090660&page=2&q=dippy> **B.** In left dorsolateral view, probably taken from the room of the museum. The mount is almost complete, with only the forelimbs, their girdles and the dorsal ribs yet to be attached. Note that, contra Untermann (1959:367–368), the skull is already in place. https://collections.lib.utah.edu/details?id=1090647&q=dippy

**Figure F.** The completed outdoor *Diplodocus* mount in a rare colour photograph. Undated. <https://collections.lib.utah.edu/details?id=415530&q=dippy>

**Figure G.** The outdoor *Diplodocus* mount is repainted on 22 June 1967, in what was likely an annual event. Field House employee Ivan Hall applies a mixture of linseed oil and brown stain while G. Ernest Untermann holds the ladder. From <https://collections.lib.utah.edu/details?id=1091738&q=dippy>

**Figure H.** The original *Diplodocus* molds being loaded onto a truck for shipment to the Rocky Mount Children’s Museum, North Carolina, on or shortly before 14 July 1960. From left to right: truck driver William Randolph Turnage, Field House employee Dee Hall, and Field House director G. Ernest Untermann. From <https://collections.lib.utah.edu/details?id=1086142>