



16 May 1989

Sue Ann Bilbey, Curator
Utah Field House of Natural History State Park
235 East Main
Vernal, Utah 84078

Dear Sue Ann:

The history of the Diplodocus molds and casts is very interesting and even more so with the Las Vegas Museum wrinkle supplied by Lucky Murdock, the former director.

I don't quite know who or how to approach the project because our intention would be to make a limited number of replicas, probably under fifteen; which would allow us to absorb the mold costs, stabilize and move your skeleton, make an extra copy for the Field House, and realize a profit on the project. We would also handle the replacement parts requested by some museums in the past.

In short, this is a very big, expensive project which we would like to work on, but it appears that details and approvals may become too tedious to deal with. Having read the draft memo, where do we go next?

Sincerely,

James H. Madsen Jr.





Norman H. Bangerter

Governor

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Division Director

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF PARKS AND RECREATION

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M.E.M.O.R.A.N.D.U.M.

August 28, 1990

TO: Jerry Miller, Director

FROM: Alden H. Hamblin, Park Superintendent
Utah Field House of Natural History State Park

SUBJECT: Dinolab Royalty on Diplodocus reproductions

As you will recall, Dinolab is contracting with the Division to refurbish and make new molds of the Diplodocus skeleton which had stood on the grounds of the Utah Field House for over 32 years. Dinolab, as part of this agreement, has the right to reproduce and sell up to 15 copies of this skeleton over a ten year period. Each skeleton they do sell means a \$5000 royalty for the Utah Field House of Natural History State Park to be used for additional skeletons, models or other exhibits at the Utah Field House such as our Brachiosaur project.

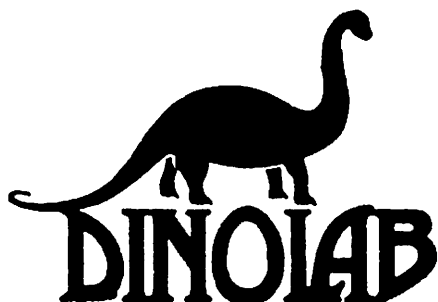
While this has all been discussed informally with you and others as to the intended use of the royalty, it has not been formally put in written form. So as to avoid confusion in the future as to what this royalty is to be used for and to keep it from getting used or directed to some other area, it is felt that there should be documentation signed by you to this effect.

Also we need to know if the ^{USE} current donation account for the Utah Field House is the appropriate place for deposit of this royalty or if some other account will need to be set up.

If you agree to the above statements about the intended use of royalty payments made by Dinolab for reproduction of the Diplodocus skeleton, would you please sign in the space provided below.

Thank You.

 Date 9/5/90
Jerry A. Miller, Director
Utah Division of Parks & Recreation



MEMORANDUM

29 January 1993

To: Dr. Mary Dawson
Carnegie Museum of Natural History
Pittsburg, Pennsylvania

Mr. Alden Hamblin
Utah Field House of Nat. Hist. State Park
Vernal, Utah

From: Jim Madsen
DINOLAB, Inc.
Salt Lake City, UT

Re: Royalties and Distribution of Skeletal Replicas, Diplodocus
carnegii

<u>Clients</u>	<u>Destination</u>	<u>Royalties</u>	
		<u>UFHNSP</u>	<u>CMNH</u>
1-Meitetsu	Kanagawa, Japan	5,000.00	NA
2-Meitetsu	Ishikawa, Japan	5,000.00	NA
3-Mitsukoshi	traveling, Japan	5,000.00	3,500.00
4-RCI International	Tokai, Japan	5,000.00	NA



WILSON'S VIEW

THE SOUTH LAKESIDE HOTEL
LAKESIDE, CALIFORNIA

OF THE LAKESIDE HOTEL
LAKESIDE, CALIFORNIA

TO THE LAKESIDE HOTEL

THE LAKESIDE HOTEL
LAKESIDE, CALIFORNIA

THE LAKESIDE HOTEL
LAKESIDE, CALIFORNIA

THE LAKESIDE HOTEL
LAKESIDE, CALIFORNIA

THE LAKESIDE HOTEL
LAKESIDE, CALIFORNIA



"DIPPY" THE TRAFFIC STOPPER

Diplodocus has arrived in this Atomic Age of man! It's a real "traffic stopper" on the lawn of the Utah Field House of Natural History. This spectacular outdoor exhibit was dedicated on June 8, 1957, during the Utah State Lions Club convention at Vernal.

As far as is known, this skeleton is the only authentic cement replica of Diplodocus for outdoor use. In its own time, some 140 million years ago, "Dippy" is estimated to have weighed 30 tons when he roamed the Vernal area. This cement skeleton weighs 8 tons, is 76 feet long, and the head rises 21 feet above the ground. From head to tail there are 103 vertebrae, 73 of which form the tail section. It is made up of approximately 600 separate pieces which were cast, assembled and erected by the museum staff.

The project of reconstructing this sauropod extended over a three-year period. The molds from which the skeleton was cast had gathered dust and soot from the steel mills in the basement of the Carnegie Museum in Pittsburgh, Pennsylvania, for more than 40 years. Sometime after the Utah Field House of Natural History was completed in the dinosaur country of northeastern Utah, the Carnegie Museum, through the courtesy of Dr. J. Leroy Kay, offered the molds to the State Museum as a gift, if transportation could be provided. The Vernal Lions Club paid the freight charges and upon receipt of the molds they were cleaned and repaired for casting.

Considerable preliminary experimenting was done with various mixtures of cement and aggralite (a light-weight volcanic pumice product) and with cement and aragonite (a form of limestone), with dry color added to simulate the appearance of most fossil dinosaur bone. A proportion of the latter mixture was deemed best and most weather resistant for the outside exhibit.

Most of the casting was done by museum personnel at the Otto Buehner Concrete Products Co. of Salt Lake City, who made their plant facilities available to the Field House. The casts of the more complicated bones, such as large vertebrae, were made here at the museum. Casting itself required the better part of one year, as did cleaning and repairing of the molds. The third winter and spring were spent assembling the pieces to make the individual "bones." Some vertebrae, for instance, were made up of 8 or more casts to complete them. These pieces were glued together with fiberglass and reinforced with iron rod. Originally, each plaster mold bore an identifying number, but with age and use many of the numbers were obliterated, complicating the assembling of the casts. Each completed "bone" was joined to its neighbor by iron rod and fiberglass and all crevices and joints filled with a grout mixture of cement and fiberglass in order to weatherproof them and

reduce the destructive effects of freezing and thawing of accumulated moisture, after being set up outdoors.

Short lengths of smaller neck and tail vertebrae were joined inside the museum to facilitate handling outside, but heavy casts were carried out individually and assembled with hysters and block and tackle. The heavy pelvis was first placed over a large iron pipe which had been cemented in the concrete base outside. Hind legs and feet were next attached, proper position determined, and welded in place. Dorsal vertebrae were then welded to it and to one another, forward from the pelvis. Front legs and feet were set up and welded to the front dorsal vertebrae. Ribs were attached, then the neck and tail vertebrae and finally the head and small neck section which completed the assembling. The skeleton was guyed with iron rods which have enabled it to withstand 70-mile per hour gales.

Thanks to the late Andrew Carnegie, famous steel magnate and donor of public libraries, these plaster molds were made from the original, nearly perfect skeleton, which is one of the outstanding exhibits in the dinosaur hall at the Carnegie Museum. This skeleton, which is similar to the *Diplodocus* skeletons excavated at Dinosaur National Monument quarry a few miles east of the Vernal Museum, came from Sheep Creek, Wyoming, near the turn of the century, and created a great deal of interest in the scientific world. From the set of molds which Mr. Carnegie had made, 10 plaster-of-paris replicas were cast which he presented as gifts to European, South American and Mexican Museums. The *Diplodocus* at the Vernal museum is the 11th cast to be made from these molds. They will not be relegated to the basement as was formerly the case, for many other museums and schools are interested in making plaster or plastic replicas for their own institutions.

Draft *

January 1990

Diplodocus carnegiei

Production and Design

of Replica Skeletons

*This is, indeed, a draft, but tables and figures will be available as soon as practical.

Introduction/Background

The 1990 skeletal reproductions of Diplodocus carnegiei by DINOLAB take advantage of the cumulative technology acquired in the molding, casting, mounting, and exhibit of dozens of replica dinosaurs over a 30 year span of time. Among other things, this project is typified by a mounting strategy that utilizes key pieces of armature that are included in the sacrum and the major elements of the appendicular skeleton. We have also used a variety of plastics in different combinations for casting individual bones instead of the more common, all purpose, traditional plaster-of-paris of the past.

For example the elements of the axial skeleton, manus, pes, and skull are cast in W.E.P. (water extended polyester); while the ribs, ilia, femora, humeri, and scapulae/coracoids are all hollow cast in a gelcoat with fiberglass and resin. Other newly developed hollow-casting techniques may be used as well. A tinted gelcoat (resin) is used as a base in producing the fiberglass elements to simulate the natural color of the original, fossil bone. The W.E.P. parts may also be tinted to approximate the color of the original bone.

The bulk of the supporting armature will be the responsibility of the exhibitor, however, the appendicular elements and the sacrum will have the armature segments cast inside. Most elements are cast individually, which allows the exhibitor an infinite number of poses.

To simplify and expedite mounting by minimizing the drilling requirement for elements of the vertebral skeleton, some axial elements are cast around cardboard tubes that create cavities which serve as pre-drilling. Specifications for the various sections of armature are detailed in Table 1, which is keyed to Figure one.

The original skeleton of D. carnegiei may be seen at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania; where it has been on exhibit since 1907. This very popular dinosaur exhibit is a composite work consisting of parts of several incomplete diplodocid skeletons: CM 84, discovered by Coggeshall in 1899; CM 94, collected by Peterson and Gilmore in 1900; and CM 662, collected by Utterback in 1902 and 1913. A most impressive mount based just on CM 662 is presently exhibited in the Houston Museum of Natural Science in Houston, Texas.

Andrew Carnegie had the original, composite skeleton plaster molded and reproduced around the turn of the century by an Italian artisan, who painstakingly prepared approximately six hundred, individual, very intricate, plaster molds; which permitted exact plaster reproductions of virtually every bone in the skeleton. Ten cast sets of this gracile sauropod were presented to as many museums in major cities around the world, including: Mexico City, Mexico; Paris, France; Berlin, East Germany (GDR); Vienna, Austria; Madrid, Spain; London, England; La Plata, Argentina; Bologna, Italy; Munich, West Germany (FRG); and Moscow, Russia. The first set was placed on exhibit in 1905, when it was formally presented to the British Museum by Andrew Carnegie (Holland, 1906).

Years later, in 1953, those same plaster molds were requested and a loan arranged for their use by the Utah Field House of Natural History in Vernal, Utah (Unterman 1953). Over a period of several years, a complete skeleton was cast a piece at a time by the museum staff, who mounted it for exhibit outside near the west corner of the Museum. There it occupied a place of prominence as a Vernal City and Uinta Basin landmark until late May of 1989. At that time, an agreement had been reached between the Museum and DINOLAB for repair, stabilization, and construction of new molds for the production of a limited number of additional skeletons. All this after stabilizing and sealing the weathered elements that have endured the seasonal extremes of the Uinta Basin for the past 36 years.

It is evident now that the decision at that time to dismantle and repair the skeleton was a wise one, since close examination during preparation and stabilization has revealed incipient fracturing and surface deterioration due to weathering of numerous elements (Figure 2). Such damage would have been progressively more difficult, if not impossible, to repair after a few more years of precipitation and the temperature extremes typical of the harsh winters and hot summers of the Uinta Basin.

In addition to considerable repairs, alterations were also made to improve the scientific accuracy and integrity of the specimen. For example the manus and pes were earmarked for replacement with elements (or casts) provided by (?), when it was confirmed that those in the

original mount were camarasaurid rather than diplodocid (McIntosh, 1981). Extra care was taken to remove most of the more obvious molding marks and flaws remaining from the earlier casting project of 1953 (Figure 3) as well as trimming away remaining parts of the copious, supporting armature utilized in the Vernal, Utah mount (Figure 4). Old paint and other sealers were removed with a combination of water blasting and wire brushing (Figures).

The fate of the initial set of molds is somewhat in question, but Wann Langston (personal communication, 1989) suggests that they seem to have been lost, strayed, or stolen during transport from ? to ?. Principals contacted in regards to the disposition of the molds could not provide specific information. It is truly a mystery that an estimated 3-6 tons of plaster molds could simply vanish!

The essential labeling information of D. carnegiei should include information as follows: This free standing mount of Diplodocus is a composite made of parts selected from three individuals: CM34, CM94, and CM662. CM84 and 94 are from the Morrison Formation of Quarry D, also referred to as Quarry 3, at Sheep Creek, Albany County, Wyoming discovered by A. Coggeshall on 4 July 1899. CM662 is from the Morrison Formation at Quarry A on the Red Fork of the Powder River, Johnson County, Wyoming. The bulk of the original elements are now on exhibit in the Houston Museum of Natural Science (McIntosh, 1981)

? Mary Dawson (personal communication, 1990)

Interesting features of this composite skeleton of D. carnegiei that require or deserve additional reference, explanation, and interpretation in labeling are:

- 1- Pathologies: the caudal series, e.g. anterior caudals (2 & 3?), caudals 19 and 20 and 23 and 24 have fused, pathologies that may be interpreted as the result of traumatic injury and perhaps subsequent arthritic degeneration of the cartilaginous tissues at the articular interfaces or, alternatively, ossification of ligaments on the lateral surfaces of some centra (ask Berman).
- 2- Sculpted elements include the left femur and tibia.
- 3- Stratigraphic and geographic data: The Brushy Basin Member of the late Jurassic Morrison Formation of Sheep Creek, Albany County, Wyoming.
- 4- Radiometric findings?
- 5- Associated faunal/floral elements
- 6- Exact number of caudals.
- 7- Sternales

To many observers, the design and construction of free-standing dinosaur skeletons is an art form and as such, there is no standard, step-by-step procedure used by the professionals who prepare the large, fossil quadrupeds for exhibition. However, we have had a measure of success with a recipe as follows:

- 1- Secure the sacral complex to a mobile, overhead support that will permit vertical movement over a range of 0 to 14 feet above the exhibit base, working surface, or floor (Figure 5).
- 2- Mount the vertebrae in 2 meter (6') segments beginning with the anterior caudals, then two meters of posterior dorsals, and so on in alternate order to balance the cumulative load. Of course, the individual elements of the axial skeleton should be totally prepared, drilled, and fitted on the armature in advance of permanent installation - atlas/axis through distal caudals (Figure 6).
- 3- Having determined the angle at the knees and positions of the pes, the hind legs can be fitted and secured. If the skeleton is to be transported a great distance, the legs can be assembled as separate units to be attached to the sacrum at the time of exhibit installation. If the exhibition is done in-house, that is, in the museum where it is constructed, the sacrum and pelvic girdle may be assembled as a single unit, including ischia and pubes.
- 4- As well, if the skeleton is exhibited in-house instead of transported any distance, the chevrons (haemal arches) may also be permanently installed with the caudal series.
- 5- Before fixing the anterior dorsal vertebrae in place, the cross piece for the pectoral girdle must be secured to the axial armature. Next, vertebrae are added alternately; anteriorly and posteriorly, as required.
- 6- The pectoral support is designed to be contained (concealed), as nearly as possible, within the scapula/coracoid, and the humeral attachment provided through the glenoid.

7- Some of the other diplodocid reconstructions, as well as other sauropods in general, have the angle of the scapula/coracoid with the horizontal plane greater than 45 , which I think is excessive.

This steep angle gives one the impression that the animal might throw its shoulder out of joint by the simple act of taking a large foreward step. Additionally, the anterior margins of the coracoids should project only a short distance farther forward than a vertical plane containing the contact of the last cervical vertebrae and the first dorsal (Figure 7).

8- The axial armature is based on the following set of measurements and a segmental design as illustrated below (Table 1). An important first step preliminary to the actual shaping of the armature is the accurate preparation of top and side views to scale of the planned exhibit. And before committing to a series of curves that contradict the natural position of the axial skeleton, a study should be made and the exact limit of movement or rotation observed and tested between each articulating set of vertebrae. A study of existing sauropod exhibits will be useful or an original study may be conducted using a large sandbox or sandbags to support the individual elements (Figure 8).

Note: for Fig. 8, see the Ueno Park Allo photos - legs on sand bags.

FIGURES

- Figure 1. The skeleton of Diplodocus (modified from Holland, 1906).
- Figure 2. Cervical vertebrae #12 before preparation and repair.
- Figure 3. Mold marks as residual flaws of the earlier molding and casting effort.
- Figure 4. Remnant of the original supporting armature is removed with a cutting torch.
- Figure 5. Exfoliating layers of paint, sealers, and resins, are removed with (a) a wire brush and (b) a waterblaster.
- Figure 6. An electric hoist is used to suspend and move the sacral complex during mounting.
- Figure 7. The anterior caudal series shown permanently mounted in a six foot section.
- Figure 8. The scapula/coracoid in left lateral view showing preferred position in a standing, quadrapedal pose.
- Figure 9. Views of six well-known Diplodocus exhibits: a) Houston, Texas, b) Washington, D.C., c) Vienna, Austria, d) Denver, Colorado, e) Paris, France, f) Mexico City, Mexico, and g) London, England.

Table 1. Description of individual sections and critical measurements.

Table 2.

Table 3.

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