DIFFICULT EXCAVATION AND PREPARATION OF A LARGE *DASPLETOSAURUS* SPECIMEN

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Abstract

A difficult combination of soft matrix, soft fractured bone, low overburden, plant root damage, weathering and a high degree of specimen articulation posed special problems in the recovery of a *Daspletosaurus torusus* Russell skeleton, RMDRC 06-005. Traditional jacketing methods yielded unsatisfactory results, therefore the Pallet method was used to remove large numbers of inseparable elements. Mechanical preparation proved impossible without consolidation of both the fossil material and the surrounding matrix with low strength cyanoacrylate adhesives. Preparation was then accomplished mainly by air abrasion.

Keywords: **Pallet, jacket, consolidation, field methods, *Daspletosaurus***

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Introduction

Discovered in 2005 and recovered in 2006, RMDRC 06-005 has been identified as a large (11 m) *Daspletosaurus torosus* Russell from the Campanian upper Judith River Formation, Fergus County, Montana. It was found with the dorsal, sacral and proximal caudal vertebrae, right ilium, dorsal ribs, and proximal chevrons articulated, along with a large mass of gastralia, scapulae and forelimbs concentrated in one area. Excavation was swift due to the softness of the matrix and total lack of concretion. The matrix consisted of a silty fine grained grey sandstone, with two distinct layers of shale chip clasts immediately above the bottom of the bone layer. Only light hand tools (brushes, trowels, shovels) were needed. The bone itself was heavily fractured on its surface, with a soft, punky interior. The matrix appeared to provide all of the support to the fossil, and special care was taken to ensure the material could be safely transported over 1300km from digsite to lab.

Institutional abbreviations: **RMDRC**, Rocky Mountain Dinosaur Resource Center; **UNO,** University of New Orleans; **LDP** Lance Dinosaur Project.

Materials and Methods

Excavation

The site is located on a gently sloping rise, with an average of 0.5m of overburden covering the skeleton. The sandstone matrix was poorly cemented and very soft. Bone quality had degraded and become problematic for two reasons. First, the low overburden allowed plant roots to invade and partially demineralize the fossil. Secondly, the increased exposure to subsurface weathering due to water infiltration and freeze/thaw cycles had shattered the weakened fossil material, though the fragments themselves had not moved relative to each other, with few resulting gaps. The surface bone is only marginally harder than surrounding matrix. Cancellous interior bone was not exposed except when field crew workers exposed it with hand tools. It was determined by the field crew that substantial hardening of the fossil and the matrix was required to safely recover the specimen. An absolute minimum amount of the bone was exposed in the field and much more matrix was taken in field jackets than normal.

FIGURE 1: Field photograph showing articulation of main jacket.

The initial field crew was not completely prepared for a dig of this magnitude, so a commercial water based urethane sealant was originally procured locally as an off-the-shelf consolidant, however results were unsatisfactory due to clouding, peeling and poor penetration of the bone and matrix. Later, a solution of Vinac B-15 in acetone, as well as Paleobond PB 4417 low strength cyanoacrylate were brought to the site by a supplemental field crew, and were utilized in consolidation before jacketing and removal, with more satisfactory results. The Paleobond PB 4417 was only applied on and immediately around exposed bone, with over one gallon used. Vinac was used as the bulk matrix consolidant because large amounts could be mixed at the site, and its penetration abilities could be controlled with adjustments to the solvent concentration. In rare cases, Paleobond PB 002 penetrant stabilizer was employed for severe damage,or when the interior cancellous bone was exposed, totaling less than 1 pint of adhesive. In total, 72 plaster and burlap field jackets

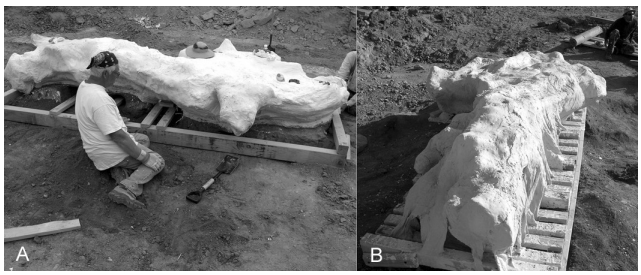

FIGURE 2: A. Main jacket capped with frame being installed **B.** Main jacket after installation of pallet.

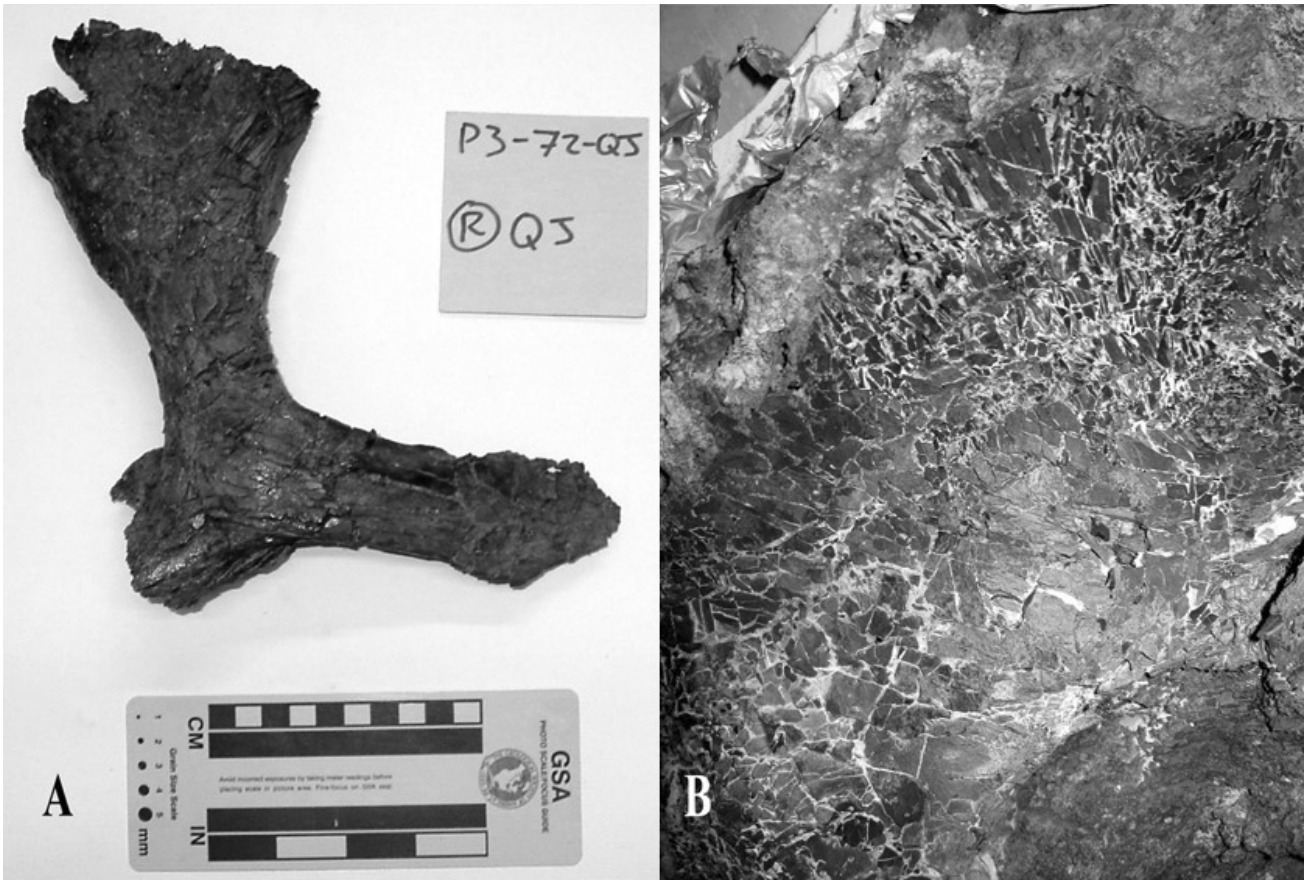

FIGURE 3: A. Right quadratojugal and **B.** left scapulocoracoid illustrating fragmentary nature of the bone.

with heavy duty aluminum foil separator were removed from the site. Due to the fragility of the specimen, even the smallest individual bones were recovered with plaster jackets, instead of traditional aluminum foil jackets. The smaller plaster jackets were prepared for removal as described by Converse (1984).

The largest and final jacket contained the main portion of the body as well as a significant number of gastral elements that were not separable in the field, well over 100 individual elements. The decision was made to recover the mass as one gigantic jacket. Because of the size, traditional jacketing and rolling techniques were impossible. The perimetered specimen and matrix were hardened with additional Vinac B 15, exposed bone covered with heavy duty aluminum foil, and a plaster and burlap cap jacket was applied.

A timber frame was constructed around and under the block using 4”x4” and 4”x6” posts fastened with 1/4” lag screws and washers. Tunnels were cut well under the specimen perpendicular to the long axis of the frame. Plaster (roughly equivalent to number 2 potting plaster) and burlap strips were then wrapped under the specimen through the tunnels, connecting to the cap jacket. 2”x4” cross beams were installed through the tunnels under the plaster strips and fastened to the frame using screws. Plaster and burlap wads were used to fill any space between the jacket and cross beams, and strips were wrapped under the cross beams and connected to the cap jacket for increased stability. These strips never went around the main frame rails in case the jacket is moved like a sled. The process was repeated until the jacket had totally encapsulated the specimen and was free of the underlying matrix. The jacket was then winched onto a trailer with come alongs and secured with heavy duty straps for transport. In total, over 500 pounds of plaster was used, with the jacket weighing approximately 4 tons. The UNO specimen LDP 987-1 “Rhonda” is an example of previous use of this method, on an articulated *Edmontosaurus annectens* mummy (Derstler pers. comm. 2008). Similarities between the specimens (large articulated animals) was the reason the pallet jacket method was used. This type of jacket differs from the RONDAN jacket in that the support structure is intended to be

permanent, the underside of the jacket is constructed before moving, and the jacket is never rolled at any time (Peterson et al 1999).

Preparation

Daspletosaurus specimens are relatively uncommon. This specimen will be molded and the original bones mounted upon completion of preparation. Though the field consolidation enabled the jackets and their contents to be returned to the lab relatively damage free, extensive consolidation must be employed during preparation. Because of the extremely fragmentary nature of the bone, reversibility of the bonds is not a major concern. All consolidants are documented on preparation logs for future reference. The small jackets are prepared upside down relative to its position in the field through the extremely soft matrix. There are multiple reasons for this approach. First, all jackets were made covering the top and sides, with the matrix underside unjacketed. Secondly, it enables preparation to commence with the already consolidated side providing support and stability. Lastly, company field protocol calls for foil separator to be used only on exposed bone, with the matrix bonding to the plaster jacket for increased stability. This makes removal of the jacket as an initial step problematic, risking unnecessary damage to the specimen.

When bone is encountered, it is immediately saturated, along with the surrounding matrix, with Paleobond PB 4417 consolidant. This low strength adhesive is a very low viscosity liquid, and penetrates well, however does not harden matrix to bone like Paleobond PB 002. Vinac B-15 is too weak of an adhesive for this project's goals, however a coat is used as the last step in preparation to ensure all microfractures are stabilized. Thicker viscosity adhesives are rarely used, only to join two elements that may have been separated during excavation. The resulting mass can then be slowly prepared exclusively with air abrasion using Armex electronics formula sodium bicarbonate media at low to moderate pressures.

Air abrasion of consolidated bone is the only satisfactory method of removing matrix without damaging bone surface. Small jackets and individual bones are prepared inside “Blast box” workstations, whereas larger jackets require a temporary tent of plastic dropcloth material to control dust, both using dust collection systems. In many cases, individual bones in larger jackets are carefully isolated, jacketed, and separated before being worked on individually. Pneumatic impact tools such as Aro or Chicago Pneumatic air scribes cannot be utilized for matrix removal as the vibration created is too great, leading to damage of the specimen. Unconsolidated bone surface is too friable to allow use of hand tools, and consolidated matrix is generally too hard, transmitting vibrations through the specimen to unconsolidated portions.

Conclusions

The pallet method for jacket construction is an alternative to rolling large field jackets when heavy equipment is neither feasable or available, or if the specimen requires more delicate handling than usual. The wooden construction is cheap, light and strong, and easy to construct with basic hand and power tools. The frame provides an additional benefit in relieving much strain from the plaster jacket itself. The total amount of plaster and burlap material used is comparable to traditional jackets. This method was again used with great success in the recovery of RMDRC 07-020, a smaller, partially articulated *Lambeosaurus* specimen the following year, where the frame rails were used to slide the jacket 15m up a steep incline.

The shattered nature of this specimen required a specific method of preparation to ready the bones for display and molding. Field use of Paleobond PB 4417 and Vinac B-25 helped stabilize the fossil and matrix during transport from Montana to Colorado. Consolidation with a low-strength reversible low viscosity cyanoacrylate adhesive in the lab enables the very fragmentary bone material to be hardened in-situ before preparation. Higher strength penetrating cyanoacrylates such as Paleobond PB 002 harden the bone well, however overharden matrix and gypsum encrustation, requiring more time for matrix removal and increasing the risk of damage to the bone. Once stabilized, the most time effective and least damaging method of preparation is air abrasion.

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