

SCIENCE MUSEUM OF MINNESOTA MONOGRAPH VOL. 8

HISTORY OF THE POISON CREEK EXPEDITIONS

1976 – 1990

WITH DESCRIPTION OF HAPLOCANTHOSAURUS

POST CRANIALS AND A SUBADULT DIPLODOCID SKULL

Bruce R. Erickson



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The Science Museum of Minnesota

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Frontispiece: Poison Creek Quarry during late 1980s. Field crew members removing jacketed dinosaur bones – many with heavy splints for reinforcement during journey to the museum laboratory.

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Bruce R. Erickson, Fitzpatrick Curator of Paleontology

PROLOGUE

In June of 1976 the Poison Creek area in Johnson County, Wyoming was investigated by Tom O'Brien and myself to assess the potential for recovery of Jurassic dinosaur remains for the Science Museum of Minnesota. A site in an area previously explored and surficially collected by biologist Lyle Bradley and his students was our main focus as it was known to yield well-preserved dinosaur bones. Specimens located by Bradley's crew during 1974 and 1975 as well as our preliminary map made during our visit in 1976 were an important assist in our evaluation of the work required to collect a sauropod skeleton and other specimens from the site.

Factors that influenced our decision to begin an excavation here were: accessibility of the selected site, the variety of identifiable taxa present; location of a nearby source of water for making field jackets; the possibility of the presence of other Jurassic reptiles such as crocodylians and turtles; and most important was the availability of field crews to work this new site as well as the ongoing excavation at Wannagan Creek, 8 hours north, in North Dakota concurrently. Once the logistics of fielding a crew at each site were worked out the Wyoming excavation began and a quarry was established in deposits of the late Jurassic Morrison Formation south of Buffalo, Johnson County, Wyoming.

Like most seasons at Wannagan Creek Quarry so also were the field crews at Poison Creek made up of about six students, working for credit and or a stipend, as well as staff and volunteers. Refer to: History of the Wannagan Creek Expeditions 1970 – 1996, Monograph, Vol. 6: Paleontology, The Science Museum of Minnesota, June 1, 2012.

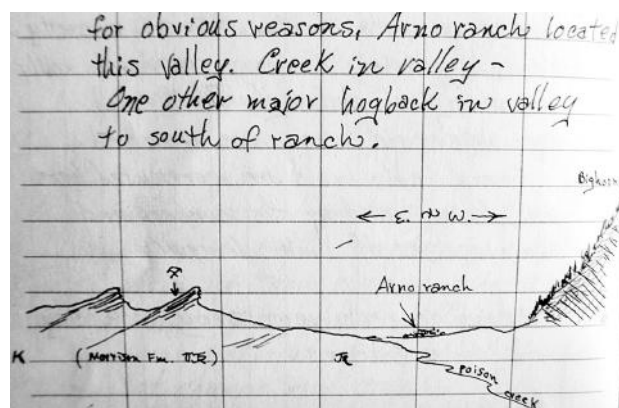


Figure 1. Field sketch showing location of quarry, ranch, and first rise of the Bighorn mountains.

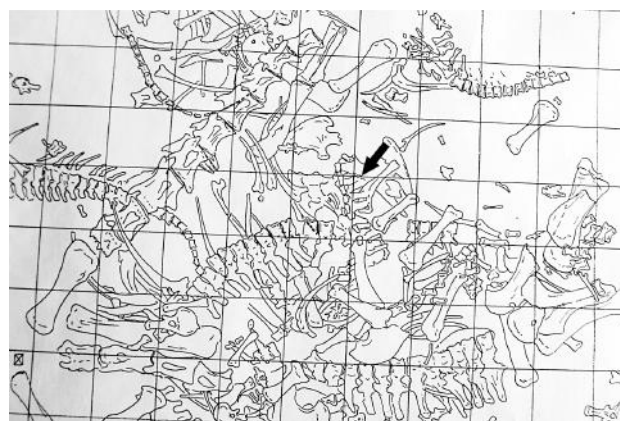


Figure 2. Field sketch of quarry map section (2 1/2 foot grid) showing location of *Camptosaurus* skeleton (arrow) mixed with sauropod bones.

As a “sidebar”, Johnson County is also of historic importance because of the famous “Johnson County War” of 1892 that saw serious troubles between local ranchers and cattle rustlers. Refer to: Wyoming Tales and Trails [http. www.wyomingtalesandtrails.com/Johnson.html](http://www.wyomingtalesandtrails.com/Johnson.html). for details.

Poison Creek Quarry which was operated from 1977 through 1990 yielded many dinosaur remains including skeletons of *Diplodocus*, *Haplocanthosaurus*, and *Camptosaurus* in addition to many separate elements of these and other dinosaurs especially those of *Camarasaurus*. One of the most notable specimens recovered from this site is the skull and mandible of a subadult diplodocid, whose description is included in this volume. A second most important specimen found at Poison Creek is a partial skeleton of the poorly known sauropod *Haplocanthosaurus*. Its description is included also in this volume.

The sediments of the Morrison Formation here were laid down under conditions similar to those of the present day Mississippi River delta region. Of the various lithofacies which characterize the Morrison, oxidized floodplain deposits of variegated mudstones of non-calcareous clays and sandstone are present at the quarry site. Distribution of skeletons and partial skeletons as well as large bones suggest that parts of their carcasses were carried into paleochannels from the floodplains where they lived and died. This is evidenced by numerous strings of vertebrae, especially those of neck and tail series which were readily separated from desiccating carcasses and moved by recurring floods. A prime example is a relocated tail indicated by the arrow in figure 15.

HISTORY OF THE POISON CREEK EXPEDITIONS: 1976 – 1990

Development of the quarry is presented in a general chronologic order of events. Other related endeavors are included whenever timely. This history is condensed into the present, annotated text.

1977

Quarry operations began in June 1977 and stretched into September with a crew of eight. Due to heavy rains in Wyoming this season drainage trenches were dug at the quarry and camp sites as a first task. Flooding of the quarry became a problem early in the season and scavenger pumps were brought in to keep the water levels down. The significant amount of “downtime” this season is attributed to the heavy rains.

Poison Creek Quarry is situated in the steeply dipping beds of the Brushey Basin Member of the Morrison Formation in the foothills just east of the first rise of the Bighorn Mountains (Fig. 1) on the sheep ranch of John Arno, NW1/4 Sec.36, T.48N, R.83W, Johnson County, Wyoming, Robinson Canyon Quadrangle 7.5 series (Figure 17). Camp was necessarily set up on a flat grassy table about one half mile from the quarry.

Even at this early stage of quarry development, notions of eventually exhibiting a sauropod were being entertained. In light of this with my research trip currently scheduled to collect and study fossil crocodylians in Germany, further arrangements were made with the Senckenberg Museum, Frankfurt-am-Main, to meet with museum director Prof. Shafer to discuss our sauropod skeleton and examine the Senckenberg sauropod. The results of our meetings will be discussed later.

Returning to Poison Creek I recognized that *Diplodocus* and *Camptosaurus* would be the first skeletons to excavate because of their mixed bones (Figs. 2 and 15). With the new challenge of a new quarry with dinosaurs rather than crocodiles as the main objective, crew members recorded a banner season for dinosaur bones. By the end of the season thirty nine field jackets had been completed and readied for shipment to the museum. Many of the bones of those two dinosaurs were beneath a layer of indurated (highly compacted) sandstone and their removal was a slow and tedious process that involved several seasons of excavation.

Concerns for the coming season's plans for collecting included locating a source of large amounts of plaster and burlap for field jackets. The local lumber yard in Buffalo agreed to furnish the needed plaster supply with regular shipments from Denver. Some 2500 pounds would be needed. The local Cenex station maintained a supply of reusable feed sacks and this became our source of burlap. Burlington Northern Railroad provided a semitrailer at Poison Creek with arrangements similar to those made for Wannagan Creek Quarry whereby jacketed dinosaur bones in this case would be loaded by the field crew during the season and transported to St. Paul by truck and rail courtesy of BNRR at the end of each season. With these primary concerns satisfied quarry work continued into September. The field season culminated with the required annual routine of site restoration by application of "Dry Pasture seed mix" and potassium nitrate to the quarry and camp areas.

1978-1979

Near the beginning of each season John Arnos' sheep were moved by mountain trail to summer pasture high in the alpine meadows of the Bighorns. When this long trek was completed Arno often assisted with the removal of large field jackets from our excavation with use of his tractor.

Work in the quarry began with the essentials of: Reviewing our excavating permits from the State Geological Survey in Laramie; installing a side of beef in a cold storage locker in Buffalo; and unpacking Arno's sheep shed where we had stored supplies and equipment since the end of last season's field work. A shower point was established also below a low waterfall on a nearby stream with the ominous name of "Poison Creek".

In the quarry the hard sandstone layer encountered during the previous season was carefully removed with hand tools such as small sledges and air hammers. A trove of undamaged dinosaur bones was exposed after the overlying debris was cleared away. Included here was a major part of *Diplodocus*. Beneath its articulated neck vertebrae, at quarry location B – 6 was the skull and mandible of a subadult diplodocid (Cover picture). This small, complete skull is arguably the most important specimen discovered at Poison Creek Quarry. The presence of this young skull as well as other bones of young individuals suggests that the diplodocids were gregarious sauropods that traveled in herds accompanied by young individuals. Removal of the large *Diplodocus* skeleton required making numerous large field jackets (Frontispiece) to insure retaining as many of the bone articulations as possible. This task extended into the following seasons. Two meters from *Diplodocus* lay the articulated pelvis of an unusually large *Camptosaurus* (arrow Fig. 2) associated with a long string of its vertebrae and other bones. At this point it also became apparent that *Camarasaurus* was well-represented including a skull lacking its mandible and many small fragments. It is regarded as the second skull from this site.

A break in the activities at the quarry due to the weather allowed me to visit Dinosaur National Monument (DNM) to examine specimens *in situ* and make osteological comparisons between sauropods. In the process of updating the Poison Creek map the recognition of another sauropod *Haplocanthosaurus* was made. Its remains were discovered at the north end of quarry which we were beginning to explore. *Haplocanthosaurus* will be discussed later with new material of its skeleton.

Unlike most of the bones from the Morrison such as those from the Garden Park Quarry, that have been severely crushed, most of the Poison Creek specimens are uncrushed and well-preserved. Pathologic evidence is limited to relatively few bones. Among the most interesting of those are two caudal sauropod vertebrae. The largest has a prominent cartilaginous projection (exostosis) on the articular face of the centrum, (Fig. 3A). In medical jargon this type of structure is often referred to as a “joint mouse”. The smaller element, probably of the same individual, has a similar incipient structure located in the same position as the first vertebra. A sternal plate belonging to the sauropod *Diplodocus* P84.15.8, has what appears to be two sets of shallow, broadly curved tooth marks near its thinnest border (Fig. 3B). If those are tooth impressions, the evidence suggest that they were caused by some non-carnivorous form.

Tooth penetration by a theropod such as *Allosaurus*, the only large predator known from Poison Creek Quarry, would have left separate, narrow depressions with a probable perforating result. The depressions conform in shape and size to the teeth of the sauropod *Camarasaurus* (Fig. 3D). They show further that the teeth were tightly apposed to one another and together formed a continuous cutting edge as described for *Camarasaurus* by McIntosh (1990). It is likely that the bitten sternal plate belonged to a dead, somewhat dismembered carcass of *Diplodocus* when it was investigated by *Camarasaurus*. This brings up the question of *Camarasaurus* feeding behavior.

The small peg-like teeth of most sauropods seem inadequate for cropping enough food material to supply the huge body (Romer, 1966; Peyer, 1968), however the food material may have been a soft-type of water vegetation and easy to feed on. *Camarasaurus* with its peculiar dentition may have been more of an opportunistic feeder able to crop vegetation as well as scrape hard surfaces such as rock or bone for adhering water vegetation. A third example of bone alteration is exhibited by the surface of a young sauropod scapula which has numerous traces from some bone parasite that fed on it (Fig. 3C). This condition found on many other bones from the site suggests the work of dermestid beetles as described for the Morrison Formation dinosaurs (Britt et al., 2008).

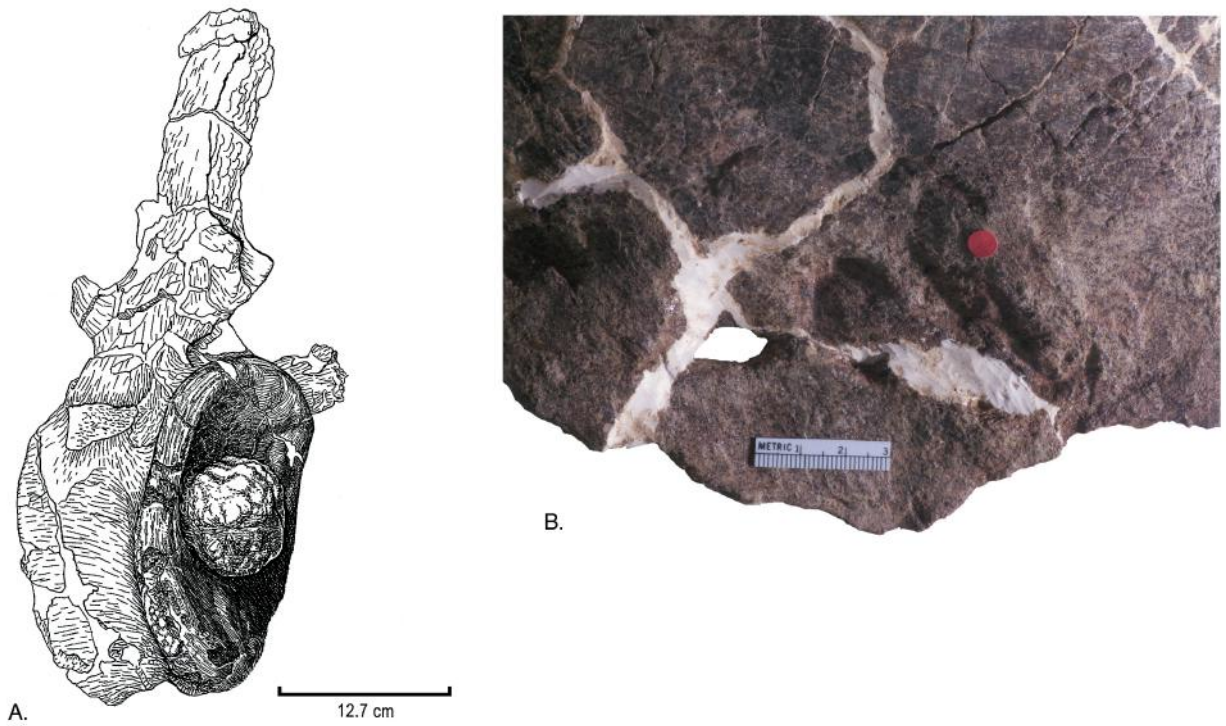


Figure 3. Pathologic evidence. A, vertebra with joint mouse; B, *Diplodocus* sternal plate bitten by the sauropod *Camarasaurus*; C, scapula of young sauropod with parasite traces (many small surface pits); D, three front teeth of *Camarasaurus*.

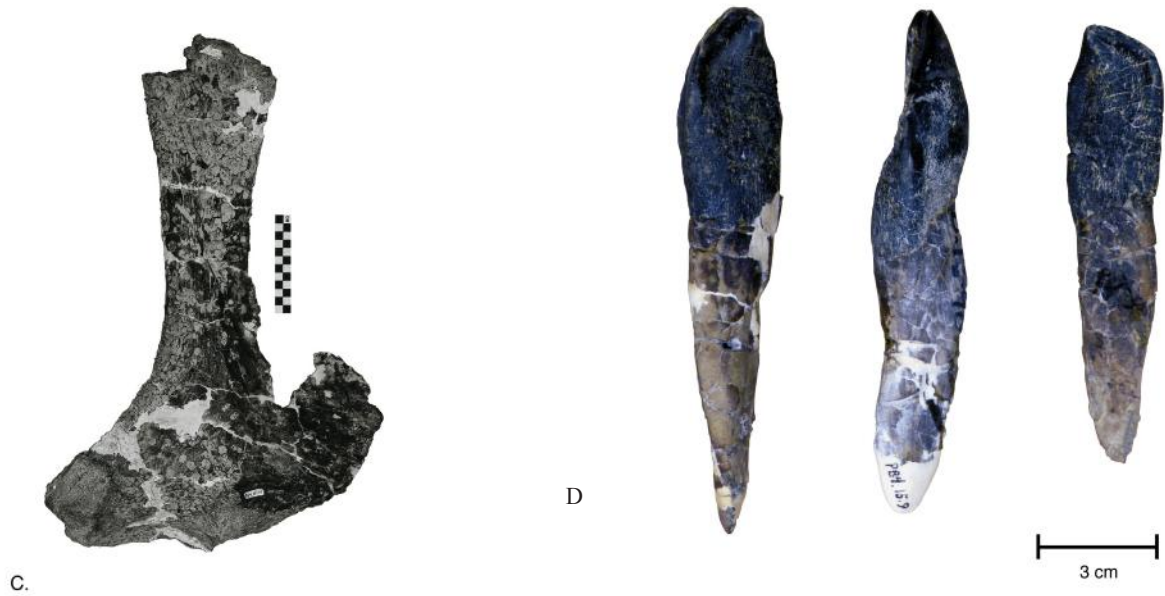




Figure 4. Quarry area with greatest concentration of probable *Haplocanthosaurus* bones.

After 57 field jackets had been removed from the quarry, plans for an intensive excavation of *Diplodocus*, *Camptosaurus*, and the newly found *Haplocanthosaurus* during the next three or four seasons were set. The budget was finally in hand and the crew was anxious to resume digging and all that goes with it. For example, on more than one occasion the crew was called upon to assist forest service personnel in fighting local forest fires west of our quarry site.

1980 – 1981

During those seasons major portions of the two earlier skeletons were partially removed before turning to the excavation of the more scattered sections of the *Haplocanthosaurus* skeleton which we located in 1978 at the north end of the quarry. Figure 4 shows a concentration of probable *Haplocanthosaurus* bones at quarry locations Z, A – 10 and 11 near the north part of the quarry (See map Fig. 15).

The greatest concentration of bones in Poison Creek Quarry produced the skeletons of *Diplodocus* and *Camptosaurus* that were eventually mounted at SMM. Here can be seen the mixed accumulation of bones attributed to moving water. Articulated neck vertebrae of *Diplodocus*, fractured and separated at the level of the eleventh cervical vertebra, also is shown in figure 2. As noted above the skeleton of *Camptosaurus* was found near the center of this accumulation of dinosaur bones at quarry locations 5 – C and D (Fig. 15).

Further exploration toward the southern end of the quarry yielded more dinosaur elements and the first evidence of crocodylians by the presence of an isolated osteoderm, probably representing the mesosuchian crocodile *Goniopholis*, at quarry location G – 1. As time allowed additional investigations were conducted in the Morrison Formation in the Como Bluff area of Albany County, Wyoming, where many Jurassic dinosaurs are present. This area also holds a wealth of *Goniopholis* material as well which was to be important in my future research on crocodylians. Crocodylians today inhabit environments not unlike those known to Morrison dinosaurs. Evidence for this is found in the abundant remains of such forms as *Goniopholis* in the Como Bluff region of Wyoming. For a historical sketch of the Como Bluff area see Marsh's Dinosaurs, the collection from Como Bluff by John H. Ostrom and John S. McIntosh 1966. Sauropod materials from here as well as that from DNM provided still more information needed for analysis of the Poison Creek assemblage. While visiting DNM at this time I also examined *Stegosaurus* bones and a cast of a newly discovered subadult



Figure 5. Original *Diplodocus* mount at SMM, 1991.

Stegosaurus was acquired as a gift from DNM to SMM.

As in previous seasons occasional trips were made between the Wyoming and North Dakota quarries to coordinate progress at each site. In Wyoming a large crew of regulars and a number of part time volunteers recovered 63 field jackets containing over 100 dinosaur bones. With many field jackets arriving at the museum in St. Paul, the lengthy process of preparation was now underway. Ten lab volunteers and staff provided the needed hands and skills. With limited lab space available at the museum, other space in a nearby warehouse in St. Paul was provided by the museum for development of many large dinosaur elements preparatory to mounting two skeletons in the exhibit halls at the museum.

1982 – 1986

Ongoing research of Paleocene (Black Mingo Formation) crocodylians of South Carolina was resumed during late winter and spring seasons. This work was a collaborative effort with the Charleston Museum and the South Carolina State Museum, Columbia, South Carolina, which continued for some twelve seasons, usually during winter and early spring of each year. The study of living crocodylians also was conducted independently at Hobcaw Barony, an historic rice and indigo plantation near Georgetown, South Carolina, where I worked in present-day alligator habitat for six weeks each year mostly to observe nesting and feeding behavior of “gators”.

Upon return to Poison Creek in July of 1982 uncover of our first two dinosaurs continued. This was important because of the intermixing of their bones with those of other specimens requiring identifications. Excavation was slow because of other field commitments in North Dakota and Alberta where work on fossil and living crocodylians was underway. In spite of the “slow-going”, 112 field jackets were removed and shipped to the museum during this time. The relative abundance of bones being found initiated a revision in our plans for mounting a sauropod when it became apparent that *Diplodocus*, not *Camarasaurus* as previously thought, was our most complete sauropod. Preparation now shifted and focused on *Diplodocus*. As a result in 1991 *Diplodocus* became the first mounted dinosaur from Poison Creek (Fig. 5). Some eight years later in June 1999 the Science Museum of Minnesota relocated on a river terrace site a short distance from its former location. Here *Diplodocus*

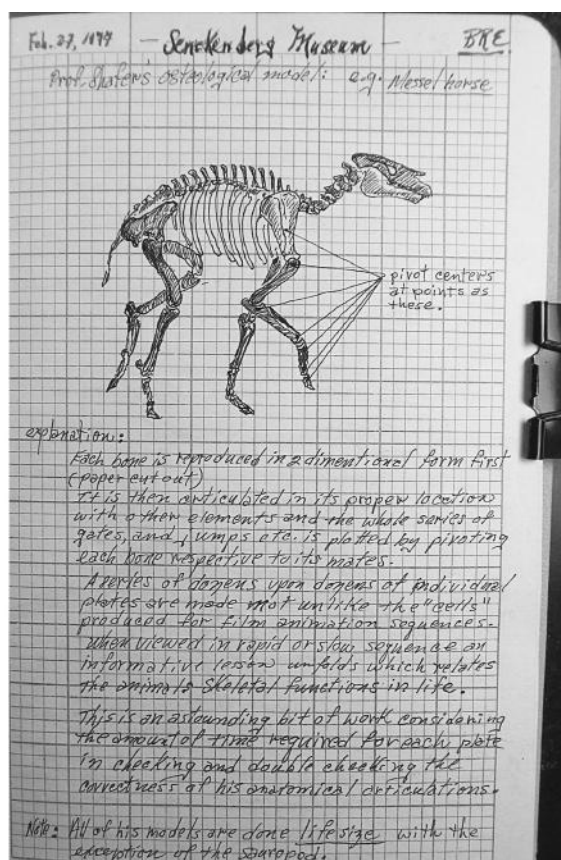


Figure 6. Field notes with sketch of fossil horse model with movable joints, Senckenberg Museum, Frankfurt am M. Germany. Model used in discussion and plan of sauropod posturing. Such cryptic field notes were also of use in mounting *Diplodocus* at SMM some years later.



Figure 7. Mounted *Camptosaurus* skeleton SMM P 84.15.5. Skeleton length approximately 25 feet.

was remounted, followed by a new mount of *Camptosaurus*, another Poison Creek dinosaur, in new settings on Kellogg Boulevard in Saint Paul.

While in Germany during 1977 a plan for the assembly and skeletal posturing of our *Diplodocus* was developed with the kind assistance of Professor/Director Shafer of the Senckenberg Museum, Frankfurt am M. The plan was based on an exhibit of “Horse Evolution” at Senckenberg. In simple terms the plan utilized a paper facsimile of a horse skeleton (field notes, Fig. 6) with pivoting joints that allowed positioning of each bone to simulate the desired posturing of the fossil skeleton. The method was applied by Shafer to revisions of the Senckenberg sauropod mount. With the necessary conversions to reptilian from mammalian anatomical elements, the method was helpful with SMM’s *Diplodocus* mount in 1991 (Fig. 5).

The second Poison Creek dinosaur to be mounted at SMM is the larger than average specimen of the ornithopod *Camptosaurus* sp. P84. 15. 5 (Fig. 7). This specimen found at quarry location C – 4 had its bones scattered beyond those coordinates; however, they were easily distinguished from most sauropod bones. The large size of this specimen is an indication of its probable affiliation to either *Camptoaurus dispar* (Gilmore, 1909) or *C. amplus* (verbal comm., Russell, 1985). An inventory of its principal postcranial bones includes: a mostly complete vertebral column, including a complete pelvis, forelimbs, scapulae, coracoids, sternals, and foot elements of the manus (Erickson, 1988).

1987 – 1988

Excavation of *Haplocanthosaurus* bones that were strung out at the north part of the quarry was by now well underway. At this point it was decided to do some prospecting on the chance of finding other locations for *Haplocanthosaurus*. Therefore, with additional permits from the BLM office in Buffalo, investigation of the coal-bearing strata east of the town of Kaycee in the open country of Johnson County began. The Cretaceous and Jurassic rocks of the Powder River Coal Basin and

Pumpkin Buttes yielded mostly marine invertebrates and little dinosaur material. An interesting deposit with many ripple patterns was discovered near a “Stock Driveway” west of Kaycee. After uncovering of this fifteen meter long sandstone deposit and removal of much sand no foot tracks or bones were found; hence, the area provided us only with a glimpse of the shallow water ponds and streams of the paleo-environment inhabited by late Jurassic dinosaurs.

1989 – 1990

Museum collections containing the established Morrison genera (*Apatasaurus*, *Barosaurus*, *Brachiosaurus*, *Camarasaurus*, *Diplodocus*, and *Haplocanthosaurus*) were visited during these years. According to McIntosh (verbal comm., 1984) *Haplocanthosaurus*, the rarest of the lot, does not seem to be present at DNM, at any of Marsh’s quarries at Como Bluff, or in the large collections from Bone Cabin Quarry. *Haplocanthosaurus* bones are present in fair numbers from Garden Park Quarry in the collections at the Smithsonian, but mostly as severely crushed elements that are difficult to identify. The presence of *Haplocanthosaurus* at Poison Creek Quarry is significant in that it is a new record of its occurrence and a number of its little known elements are well-preserved, notably limb and foot bones of the hind limb.

The many longbones (propodials and epipodials) of various dinosaurs including those of *Haplocanthosaurus* arriving at the museum presented the familiar problem of permanent storage. To facilitate their preparation and study (measuring and photographing), portable racks similar to rifle racks with adjustable stanchions, were constructed to support individual longbones in a more or less vertical position. This allowed nominal stress to each bone and provided for their care and handling. Ten such racks hold the Poison Creek longbones. The minimum number of individuals represented by each bone type (longbones as well as other bone types) in the Poison Creek assemblage is suggested by Table 1.

The two most notable specimens (the noted hind foot of *Haplocanthosaurus* and a subadult skull of *Diplodocus*) found at Poison Creek Quarry are described in the following section of this paper.

HAPLOCANTHOSAURUS SMM P 90.37.10: ASPECTS OF ITS HIND LIMB AND TAIL

Saurischia Seeley, 1877
 Sauropoda Marsh, 1878
 Cetiosauridae Lydekker, 1888
Haplocanthosaurus Hatcher, 1903

Among the numerous bones of likely *Haplocanthosaurus* origin the hind limb is described along with a section of caudal vertebrae that have distinguishing features.

The lower left hind limb and pes were articulated *in situ* (Fig. 8A). The eroded proximal upper surface of the tibia and the missing proximal end of the fibula indicates that they were not completely buried initially and were altered by erosion. The femur for this specimen has not been identified.

Tibia – the tibia P 90.37.10 is incomplete lacking about one third of its proximal end on its posterior side, whereas its anterior side is mostly intact. As preserved the tibia has a total length of 103 cm. The cnemial crest is missing. Distally the shaft is expanded medially as well as laterally and posteriorly a deep rounded notch is present for reception of a similarly rounded ascending process on the astragalus (Fig. 8 C). In medial view (Fig. 8 B) the tibia is straight and its distal end is projected posteriorly.

Fibula – the fibula P 90.37.10 is also incomplete lacking about one third of the shaft above a large muscle scar on its lateral surface and the tibial articular area on its medial surface. The muscle scar is 15 cm long and begins 52 cm from the distal tip of the fibula. Its preserved length is 77 cm. With the astragalus in place the associated fibula is estimated to have been a minimum of 110 cm. in length. The distal side is flattened medially and the end is rounded for its contact with the cavity on the edge of the astragalus (Fig. 8 C).

Two proximal tarsals are present and each is complete (Fig. 8 A -- C). Astragalus – The astragalus is the largest of the 18 sauropod astragali from Poison Creek Quarry. It is morphologically distinct when compared to that of *Camarasaurus*. In cranial view it is broader with a wider articular surface for contact of metatarsals I – III. It is tapered to a blunt medial end, and not narrowed and pointed as in *Camarasaurus*. Its anterior contact area is fully as wide as the end of the tibia. In caudal aspect this element shows a prominently rounded ascending process to engage the noted pit in the distal end of the tibia (Fig. 8C and Fig. 9 arrows B -- D).

Calcaneum – The calcaneum, 90.37.10 is relatively small, globular and somewhat heart-shaped in one aspect and rounded in other aspects (Fig. 10 A, B, C). Most of its surface is pustulose. It's one smoothest surface may have opposed the distal end of the fibula. The arrow marked on it (Fig. 10A) only indicates its position as found and does not necessarily show its position in life. Deep cavities as seen in figure 10B (arrows) suggest locations of vascular canals. This element measures 95x84x52 mm.

Pes – The hind foot is missing the proximal phalanx of digit I. Other than that the pes is regarded as complete as preserved (Fig. 8 A).

About thirty articulated caudal vertebrae (some with chevrons) were found at quarry location (5-Arrow Fig. 15). Details of these vertebrae having short centra, low anterior neural spines, large prominent chevron facets, and chevrons that are open above the haemal canal suggest an affinity to *Haplocanthosaurus*. Those morphological features of the caudal series are important in establishing the presence of *Haplocanthosaurus* at Poison Creek Quarry.

Figure 8

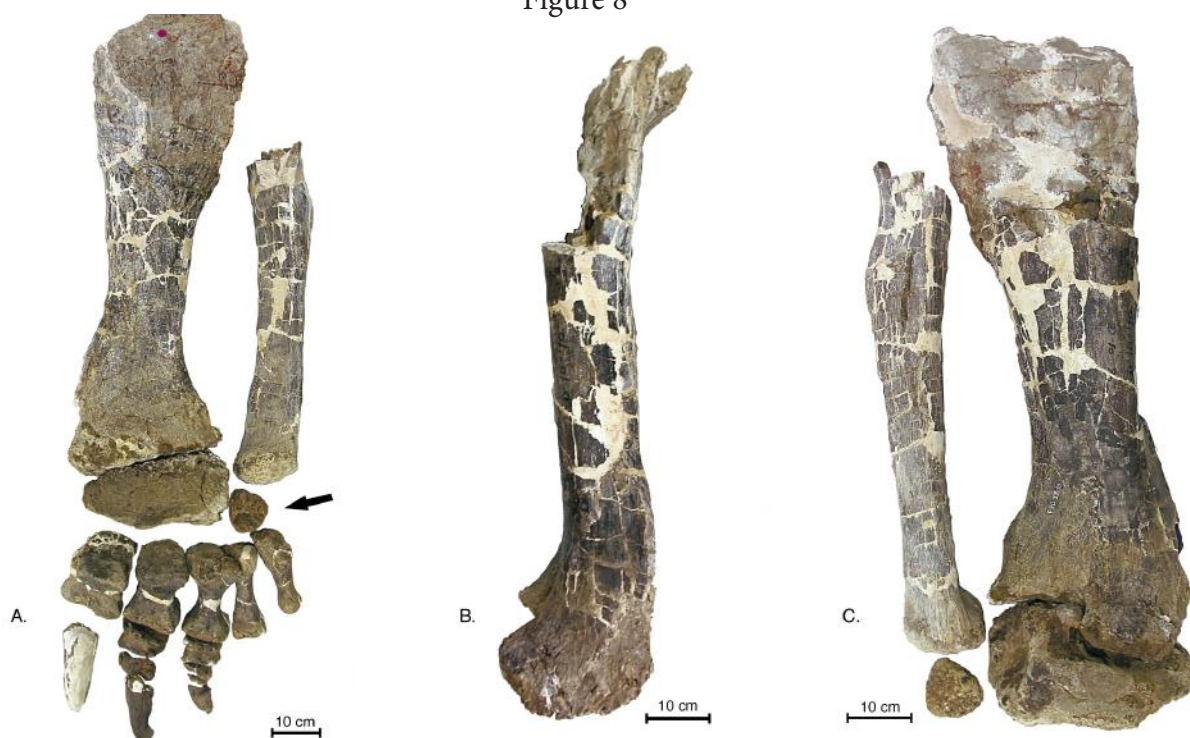


Figure 8. Lower left hind limb of *Haplocanthosaurus* SMM P 90.37.10. A, tibia, fibula, astragalus, calcaneum (arrow) and pes in cranial view; B, left tibia in medial view; C, tibia, fibula, astragalus, calcaneum in caudal view.

Figure 9

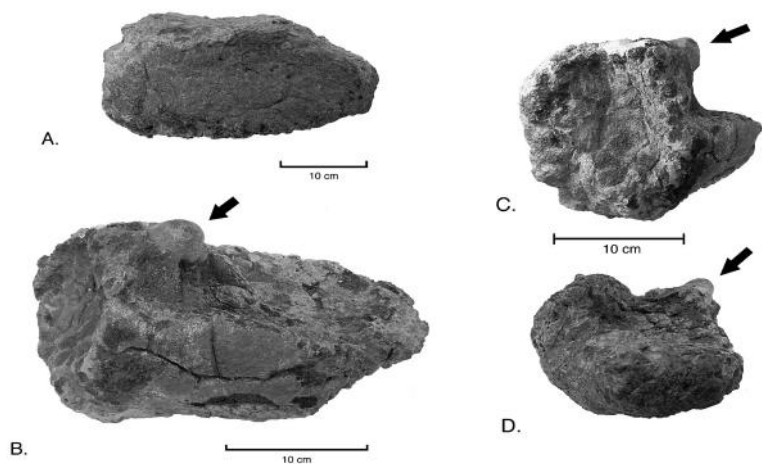


Figure 9. Left astragalus of *Haplocanthosaurus* SMM P 90.37.10 in A, cranial; B, caudal; C; medial; D, lateral views. Ascending process (arrows).

Figure 10

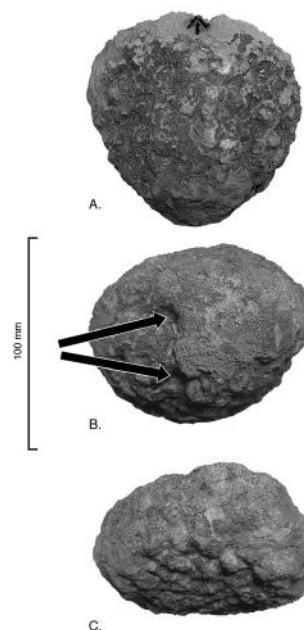


Figure 10. Left calcaneum of *Haplocanthosaurus* SMM P 90.37.10 in three views. A, heart-shaped view with field marking (arrow); B, long arrows indicate the locations of possible vascular canals; C, compressed view shows pustulose surface.

DIPLODOCID SKULL

Saurischia Seeley, 1887

Sauropoda Marsh, 1878

Diplodocidae Marsh, 1884

Diplodocus Marsh, 1878

Specimen: Skull and Mandible of Subadult *Diplodocus* SMM P84.15.3.

Horizon: Brushey Basin Member, Morrison Formation, Late Jurassic.

Location: Poison Creek Quarry NW1/4 Sec.36,T.48N, R.83 W, Johnson County, Wyoming, USA.

The skull of *Diplodocus* has been described in detail (Marsh 1895) and as a subadult (Whitlock et al.2010). The present description and analysis of a subadult skull notes aspects of a new specimen for comparative study. Unlike other specimens of subadult *Diplodocus*, the new skull has been prepared free of matrix revealing internal aspects and bone associations on the right side of the rostrum. Within the rostrum the quadrate, pterygoid, ectopterygoid, and palatine are shown without the use of CT images (Fig. 13 B). The overlap of the palatine process by a maxillary process is shown near the preantorbital fenestra and the lateral surface of the pterygoid is visible through the antorbital fenestra (Fig. 13 A, B). Organization of the germinal teeth of the maxillary is preserved as is the nature of the thin, smooth, internal wall of the maxillary.

The relative age of the young diplodocid skull is indicated by its size and its narrow snout which is bluntly pointed and not squared-off as that of an adult. Other distinguishing aspects of this specimen are its little-distorted braincase, its rostrum (orbits forward) that has been prepared internally and externally and a mostly complete mandible. The skull with its braincase and rostrum naturally associated (cover photograph) clearly defines surface details and the lateral skull openings. No evidence of scleral ossicles was found. The total length of the skull as preserved is 406 mm.

Braincase –Marsh (1895) describes the brain as being inclined and elevated to the front, with hemispheres short and the olfactory lobes well developed, separated, and close to the external nasal opening. A large pituitary was housed beneath the brain.

The posterior part of the skull (braincase) is shown in (Figure 11 A). In posterior view the skull is somewhat distorted which is attributed to its *in situ* position beneath the neck of the adult *Diplodocus*. Most of the bones, especially on the left side, retain their integrity with interstitial spaces separating them. Some elements such as the exoccipital show signs (small pits) which suggest modification by some bioerosional agent(s).

In anterior view (Fig. 11 B) the braincase preserves its anterior wall with its elevated opening (fm) for the olfactory lobes of the brain, the basisphenoid and its processes. The skull table is intact with the exception of the posterior margin of the external narial opening which is suggested by a dashed line (Fig. 11 C). The bones at the perimeter of the skull table are irregular and rugose in texture.

Internal views of the braincase are shown in coronal, axial, and sagittal sections by computed tomography (CT scans) (in figure 12A – I).

Rostrum – The lateral view of the rostrum anterior of the orbits (Fig. 13 A) has a smooth texture and the bone is very thin with numerous perforations. Thickness of the bone at the edges of openings varies between 1.5 and 1.8mm. Ten teeth are externally visible in the maxillary and one is present in the premaxillary. Internally the right half of the rostrum (Fig. 13 B) has been prepared to expose the palatine – pterygoid complex as it has been preserved. The premaxillary is mostly missing and retains a single tooth at the jaw margin.

Mandible – the mandible of P84.15.3 was preserved with the skull as shown in the cover photograph. In occlusal view (Fig. 14 A) the dentaries are joined by a short incomplete symphysis and forms a bluntly pointed snout as in the skull. Splenials are present but do not reach the level of the symphysis. In right lateral view (Fig. 14 B) the anterior end of the mandible angles downward but lacks the deep “chin” development seen in the adult. About 11 teeth are present in the right mandibular half. It measures 286 mm along midline.

Dentition – As noted for the type specimen of *Diplodocus longus* (Marsh 1895) there are 4 teeth in each premaxillary; 9 teeth are present in each maxillary and 10 in each dentary of the mandible. The present subadult skull has a single tooth in the incomplete premaxillary; 10 in the maxillary and 12 in the dentary. The difference in age of the present specimen and the type specimen may account for the difference in the mandibular tooth count.

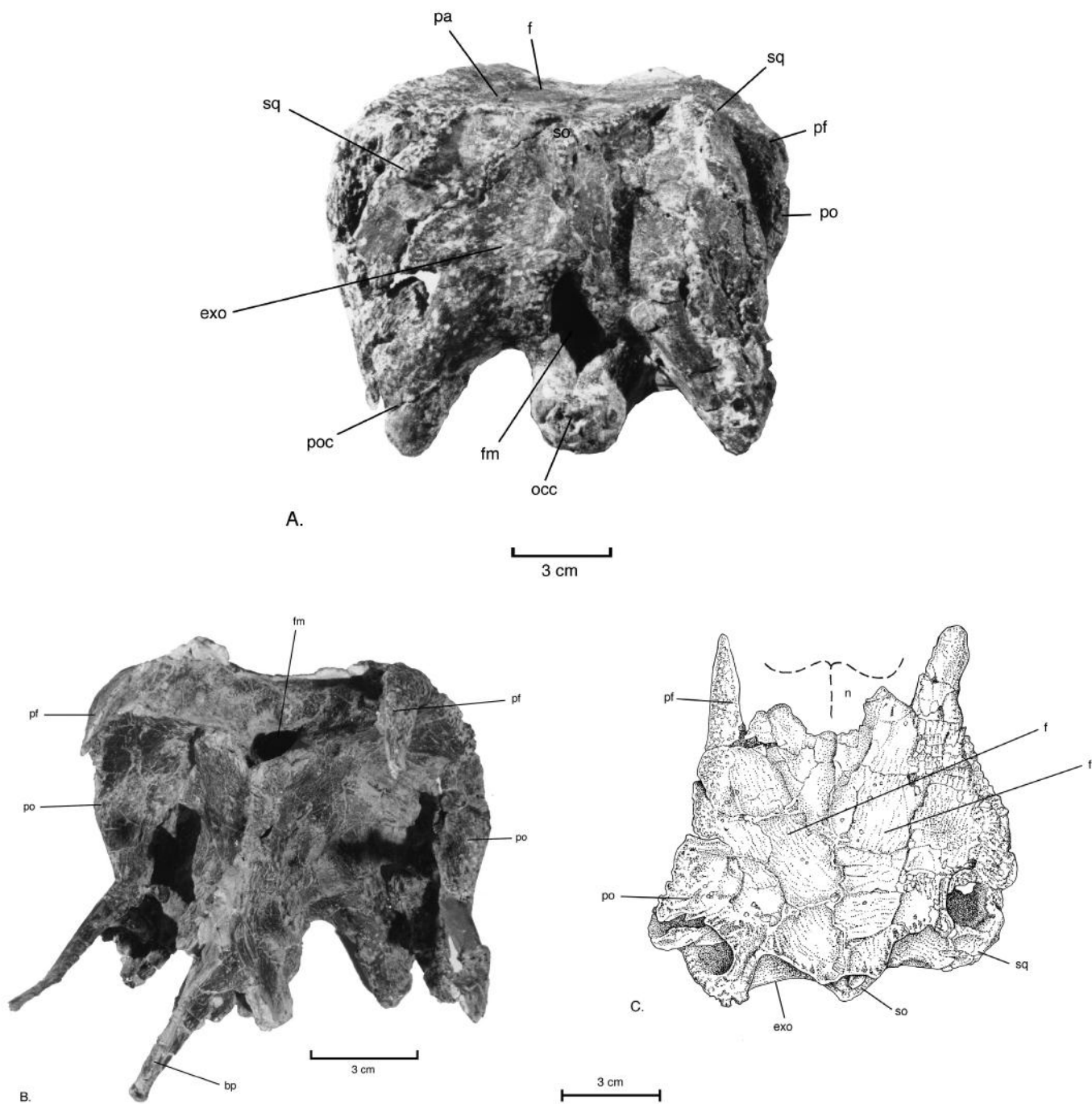


Figure 11. Brainscase of *Diplodocus* SMM P 84.15.3; A, photograph of posterior view; B, photograph of anterior view; C, illustration of cranial roof in dorsal view. Abbreviations: bp, basioccipital process; exo, exoccipital; f, frontal; fm, foramen magnum; n, nasal; occ, occipital condyle; of, olfactory foramen; pa, parietal; pf, postfrontal; po, postorbital, poc, paraoccipital process; so, supraoccipital; sq, squamosal

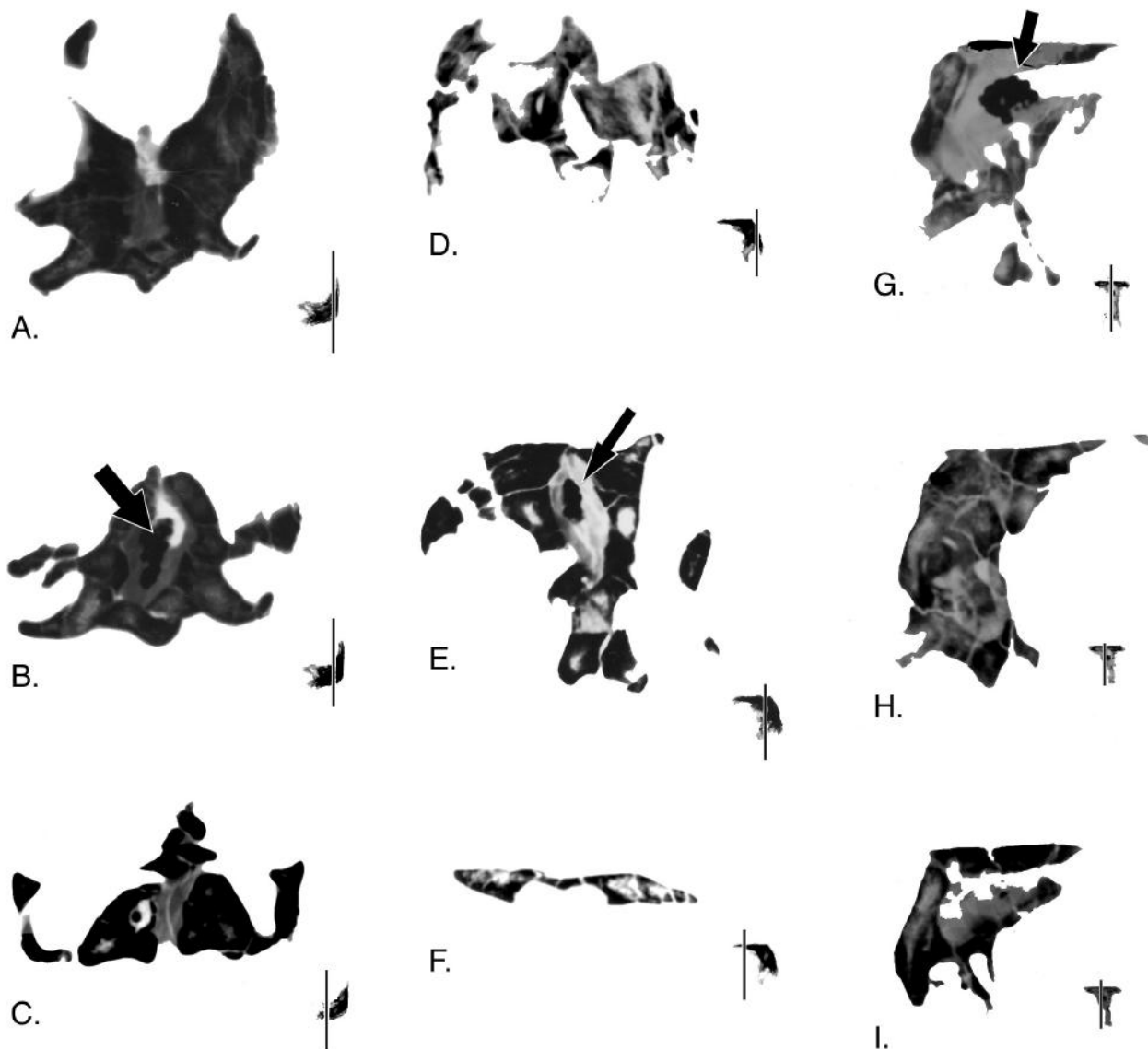


Figure 12. *Diplodocus* skull SMM P 84.15.3 brain case internal views. Each CT scan is accompanied by a radiograph (lower right) indicating the level of the CT scan
Coronal sections: A, skull roof; B, upper view of brain cavity; C, lower view of brain cavity through foramen magnum. Axial sections: D, occipital region; E, mid brain cavity; F, skull roof anterior of main cavity. Sagittal sections: G, left side of brain cavity showing sutures and openings of cranial nerve stalks for V – XII; H, occipital region near midline showing sutures; I, left side of brain case. Pyrite inclusion indicated (arrows in B, E, G).

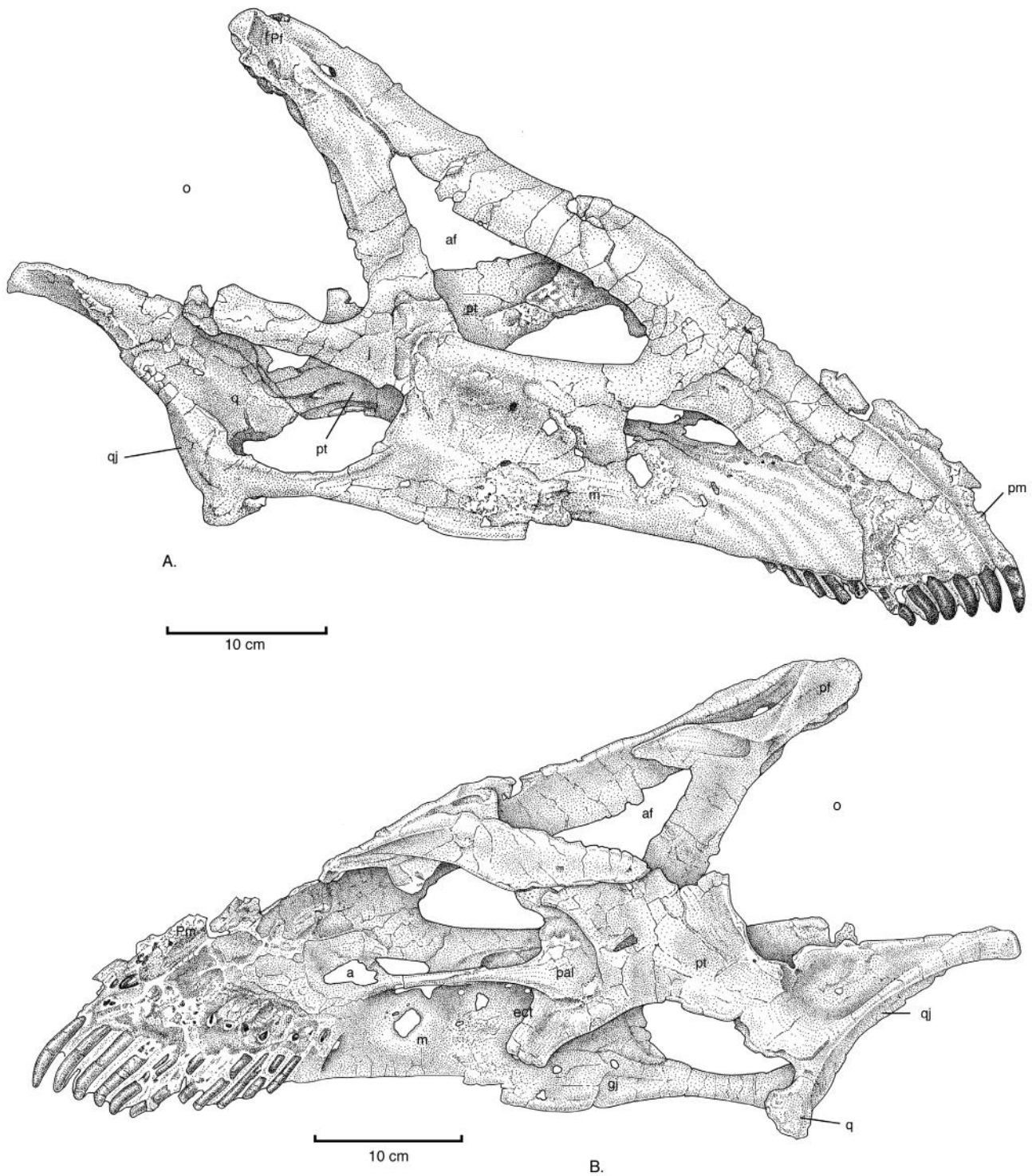


Figure 13. Rostrum of *Diplodocus* skull SMM P 84.15.3. A, exterior surface in right lateral view; B, interior view; abbreviations: a, preantorbital fenestra; af, antorbital fenestra; ect, ectopterygoid; m, maxilla; o, orbit; pal, palatine; pf, prefrontal; pm, premaxilla; pt pterygoid; q, quadrate; qj, quadratojugal.

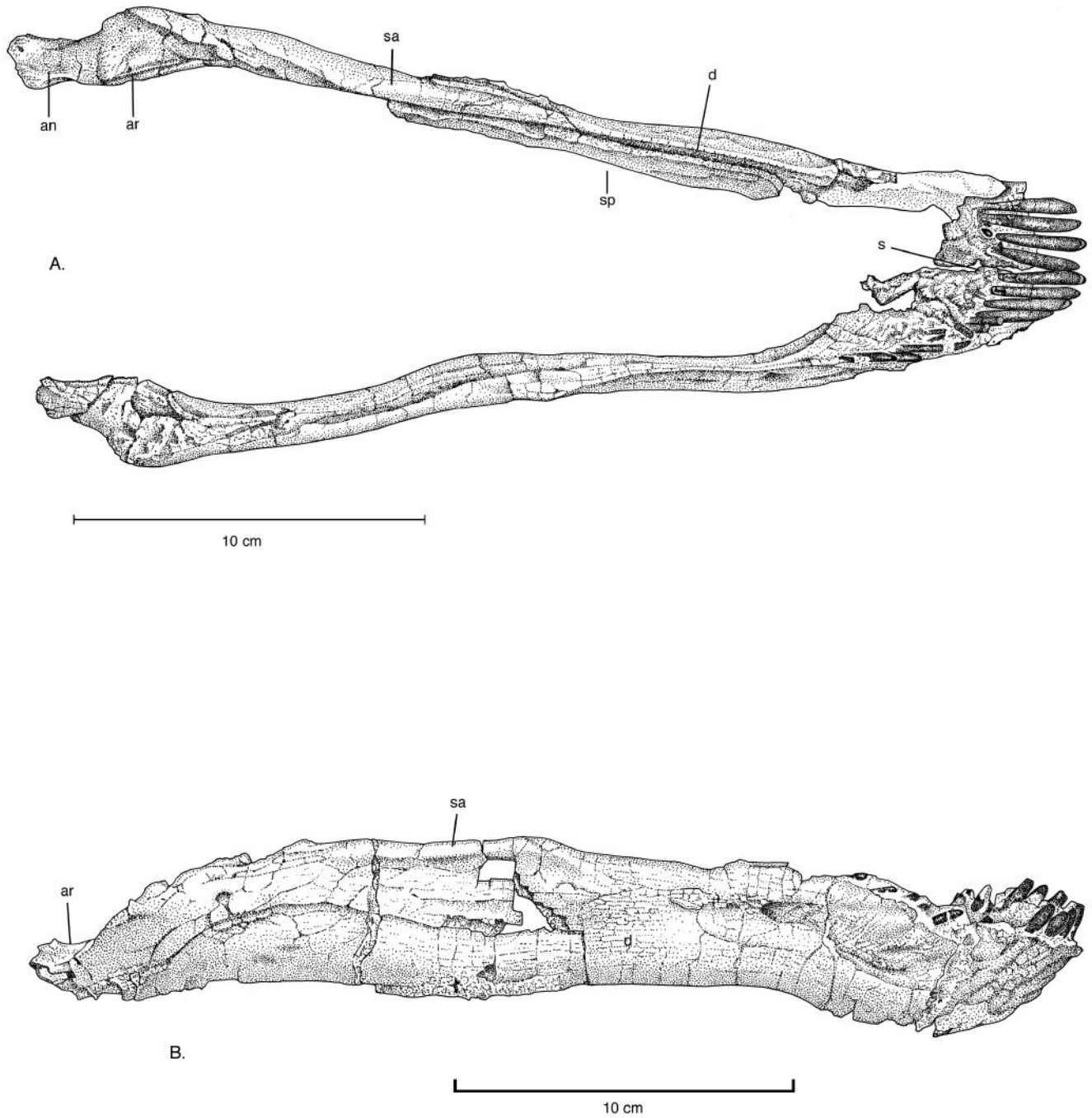


Figure 14. Mandible of *Diplodocus* skull SMM P 84.15.3. A, occlusal view; B, right lateral view; abbreviations: an, angular; ar, articular; d, dentary; s, symphysis; sa, surangular; sp, splenial.

TABLE I

PP = Postcranial Bones Present in Quarry.

MNI = Minimum Number of Individuals present.

<u>PP</u>		<u>MNI</u>
Humeri	(14)	7
Radii	(9)	5
Ulnae	(9)	5
Femora	(15)	8
Tibiae	(14)	7
Scapulae	(10)	5
Coracoids	(7)	4
Sternals	(4)	2
Ilia	(17)	9
Pubes	(16)	8
Ischia	(16)	8
Astragali	(9)	5
Calcaneum	(1)	(1)

EPILOGUE

Field work at Poison Creek began with our initial investigation during 1976 and extended into 1990. The area where the quarry was opened had been previously prospected and surficially collected by L. Bradley and his crew of biology students. The museum's quarry was opened 1977 and worked each season through 1990. During this time a few seasons were shortened due to other commitments namely at Wannagan Creek Quarry in North Dakota and other related sites. An effort to better utilize the museum field crews was attempted early on in the operation by alternating personnel between the Wyoming and North Dakota quarries. It soon became apparent that each site needed its own dedicated crew and a regular schedule was resumed for the duration of each site. The field crew of 1981 averaged about a dozen or more individuals (Fig. 16 and Appendix I).

Poison Creek Quarry yielded 666 mapped dinosaur bones in addition to about twenty other bones removed prior to our first map plot. Most numerous are the bones of sauropods representing *Apatosaurus*, *Camarasaurus*, *Diplodocus*, and *Haplocanthosaurus*. Two skulls are included in the bone assemblage. Evidence of two skulls among 600-700 bones is not an unexpected ratio for a Morrison dinosaur bone assemblage as skulls are often separated from neck vertebrae and are not found.

A remarkable find is the skull and articulated mandible of a young diplodocid. The cover photograph represents one of several subadult individuals that were part of a possible dinosaur herd that is suggested by the many associated bones of young individuals found at Poison Creek Quarry. This skull which is arguably the most important specimen found at the site affords us some new views, both internally and externally, of the skull. These views are shown in figures 11 – 14.

Numerous remains of the primitive sauropod *Haplocanthosaurus* from the quarry are also of special interest because of its articulated distal tail section of some thirty vertebrae – some with chevrons, a complete lower hind limb and foot containing previously undescribed elements such as an astragalus and calcaneum as well as other materials which contribute to a formula for the ultimate skeleton of *Haplocanthosaurus*. This is an uncommon Morrison sauropod with limited distribution. Its northernmost occurrence is Poison Creek Quarry as indicated on the Robinson Canyon Quadrangle, Johnson Co., Wyoming (Fig. 17).

As Morrison dinosaur quarries go Poison Creek Quarry was of limited size (Fig. 15) due to its perimeter which was defined by its location on a hillside and the steeply dipping floor of the quarry. Yet among the several hundred articulated and separate bones recovered, four sauropod taxa are recorded. The number of major elements of sauropod and other taxa provide a minimum number of individuals found at this site (Table I). This assemblage from Poison Creek Quarry adds significantly to the dinosaur taxa at SMM. It adds to the scope of the collections in types of dinosaurs and horizons represented. To reference the museum's dinosaurs see (Dinosaurs of the Science Museum of Minnesota Erickson, 2009)

My field notes indicate that 14 field seasons (1977 – 1990) logged a total of 840 field days for 48 field crew members (Appendix I). To clarify those numbers, visitors to the site were usually included as part of the field crew if they were on the site for more than a few days. Their duties contributed to the digging, making plaster and burlap field jackets, or assisting with the cooking for the crew. Breakfasts at Poison Creek were often enhanced by fresh trout from nearby mountain streams courtesy of crew member Ward Olson.

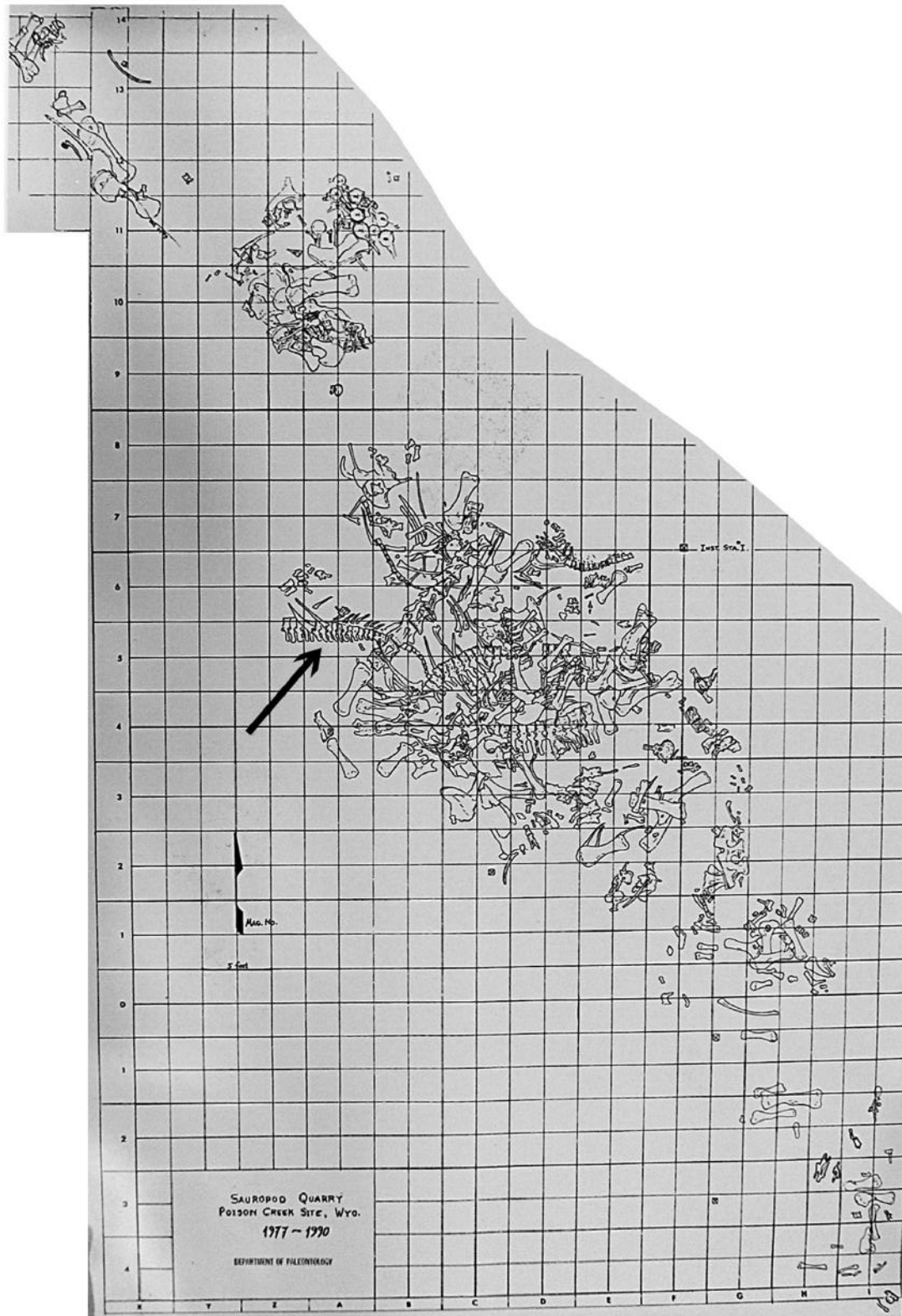
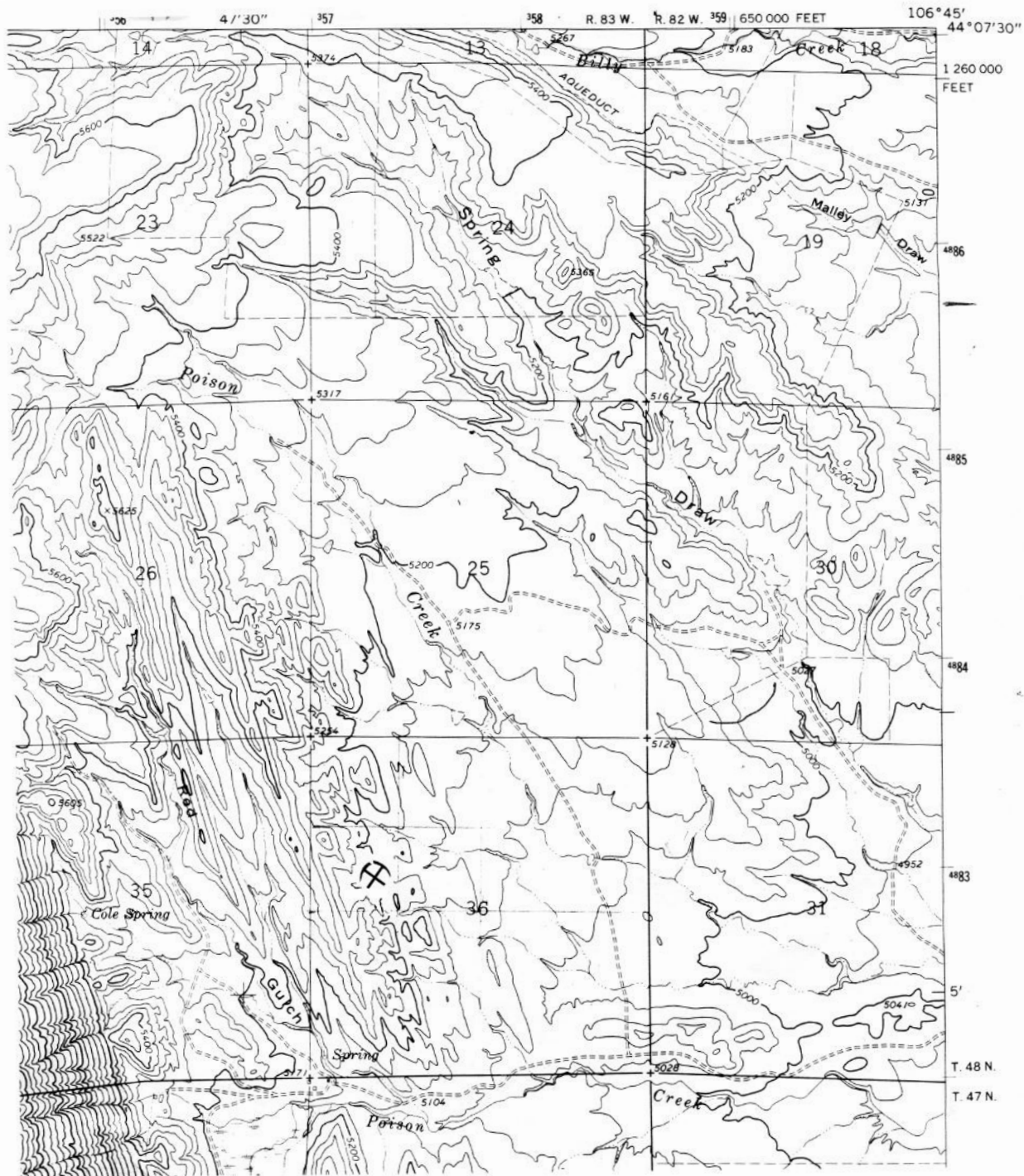


Figure 15. Map of Poison Creek Quarry Johnson County Wyoming. Distribution of the bones follows the strike of the underlying strata. Arrow shows separated tail section of *Haplocanthosaurus*.



Figure 16. Field crew of the 1981 season at Poison Creek Quarry, Johnson County, Wyoming.



ROBINSON CANYON QUADRANGLE
 WHYOMING - JOHNSON CO.
 7.5 MINUTE SERIES (TOPOGRAPHIC)

Figure 17. Poison Creek Quarry map location indicated by quarry symbol in NW 1/4. Sec.36. T. 48N. R.83W, Johnson County Wyoming.

ACKNOWLEDGEMENTS

For their contribution to this project I thank the following: All of the field crew members (Appendix I) for collecting the materials discussed herein; rancher John Arno assisted with quarry excavating and loading large field jackets with his tractor. Becky Huset and Richard D. Benson for reviewing the manuscript and providing constructive criticism; Lois O. Erickson for editing; Julie Martines for preparation of illustrations figures 11C, 13; Mark Ryan for figures 3, 8, 9, 10 as well as the cover photo; Albert Sanders, Charleston Museum, for figure 5. Robert Spading, SMM, produced all of the field images; Riverside Medical Center, Minneapolis provided the CT scans in figure 12; Timothy Erickson completed the redacting of all of the figures; William Mason (Uncommon Conglomerates, Inc.) supplied materials for the development of specimens. I also thank BNRR for transporting all of the field crates of jacketed bones from the quarry site, averaging about 50,000 pounds each season to the museum in St. Paul. Funding for the project came from the Philip W. Fitzpatrick Paleontology Research Fund and the Science Museum of Minnesota.

APPENDIX I

POISON CREEK QUARRY FIELD CREW MEMBERS
LISTED CHRONOLOGICALLY 1976 – 1990

- 1976 B.R. Erickson, T.J. O'Brien
- 1977 B.R. Erickson, C. Hudak, T. McCutcheon, T. O'Brien, G. Wraastad, R. Mjos, L. Mjos, Wm. Cahill, M. O'Brien, G. Hanson, B. Chuchel, C. Faraci, B.A. Erickson, M. Vetter, K. Sander, C. Benepe, M. Sander, J. Madsen, R. Melchior, L. Bradley.
- 1978 R. Spading, P. Ganzel, T. O'Brien, C. Faraci, R. Mjos, G. Wraalstad, A Rariamo, Wm. Cahill, B. Chuchel, D. Barassa, C. Hudak, J. Bodas, B.R. Erickson.
- 1979 B.R. Erickson, W.H. Hogenson.
- 1980 B.R. Erickson, L. Bradley, W.H. Hogenson.
- 1981 R. Spading, W. Hogenson, B.R. Erickson, T. Sawyer, B.A. Erickson, M. Nelson, T. O'Brien, L. Bradley, R. Melchior, L. Erickson, K. Zentzis, R. Morrison, S. Bradley, K. Shoop, S. Sawyer, L. Pomraning, J. Hanes, R. Loehlain.
- 1982 B.R. Erickson, T. O'Brien, R. Spading.
- 1983 R. Spading, D. Engberg, T. O'Brien, M. Leite, J. Glod, C. Heinz, K. Zentzis, L. Pomraning, N. Pickett, R. Loehlain, M. Hawkinson, L. Bradley, B.R. Erickson, C. Benepe, J. Madsen.
- 1984 B.R. Erickson, T. O'Brien.
- 1985 B.R. Erickson, W. Hogenson.
- 1986 B.R. Erickson, W. Hogenson.
- 1987 B.R. Erickson, R. Spading, T. O'Brien, R. Benson, D. Anderson, K. Cork, P. Thompson, C. Miller, B. Miller, G. Rochter, L. Bradley, Wm. Dugas, C. Benepe, M. Hawkinson, N. Pickett, B. Blenkush, S. Thomas.
- 1988 T. O'Brien, B.R. Erickson.
- 1989 B.R. Erickson, R. Spading, T. O'Brien, W. Olson, R. Benson, L. Bradley.
- 1990 R. Spading, B.R. Erickson, T. O'Brien, R. Benson, G. Post, A. Biemond, R. Zawarsky, P. Thompson, K. Cork.

Numerous volunteers, who were not members of field crews, devoted many hours to the development of dinosaur materials in the museum laboratory during and after the close of Poison Creek Quarry in 1990. This included the mounted skeletons of *Diplodocus* and *Camptosaurus* as well as the valuable dinosaur research collections of the museum.

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