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NEW INFORMATION ABOUT THE COPE COLLECTION OF SAUROPODS FROM GARDEN PARK, COLORADO

JOHN S. McINTOSH

Wesleyan University Middletown, CT 06457, USA

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Professor Edward D. Cope's large collection of sauropod dinosaur material from Garden Park, north of Cañon City, Colorado, was exhaustively described and figured in a monograph by Henry F. Osborn and Charles C. Mook in 1921. At that time it was thought that almost none of the field records concerning this collection had survived. Recent discoveries of many of these "lost" records, including Cope's own note book of observations made during his visit to the Garden Park quarries in 1879, provide much new information about the quarry sites and about the associations of the bones of the various skeletons. These new data permit corrections to be made to the Osborn–Mook monograph. They also allow further observations on the sauropod species *Camarasaurus supremus*, *Amphicoelias altus*, and *Amphicoelias fragillimus*.

Keywords: Records; Letters; Sauropods; Cope

INTRODUCTION

Before 1877, the great long-necked, long-tailed sauropod dinosaurs were very poorly understood. In that year, collectors for the archrival vertebrate paleontologists Prof. E.D. Cope of Philadelphia and Prof. O.C. Marsh of Yale University, began sending east large amounts of dinosaur materials from the American West. Collecting for Cope were two brothers, Oramel W. Lucas and Ira H. Lucas. They sent over 154 freight boxes of bones, largely sauropod, from several quarries in Garden Park, 8 miles north of Cañon City, Colorado. These bones were briefly described by Cope, who assigned the sauropod material to two new genera *Camarasaurus* and *Amphicoelias*. The entire collection was exhaustively described and figured

many years later by Prof. Henry F. Osborn and Dr. C.C. Mook (Osborn and Mook, 1921). Their effort was greatly hampered by the apparent loss of almost all the field records. The recent unexpected discovery of many of these records has allowed me to correct some errors in the Osborn and Mook monograph and to add considerably to the provenance of the different skeletons. This preliminary paper on the new findings should be considered to be an addendum to the Osborn–Mook monograph. It is hoped that it will enhance the value of that significant work.

Abbreviations and Notation. AMNH refers to the American Museum of Natural History. The individual bones are referred to in the notation of Osborn and Mook. For example, 5760/X-c-1 is cervical vertebra x-c-1 of American Museum catalogue number 5760, while 5761/Tb-1 is right tibia tb-1 of catalogue number 5761. I have numbered the known shipments from the Lucas brothers to Cope sequentially with diamond notation e.g. ⟨5⟩ is the fifth shipment, which was sent on October 21, 1877.

HISTORICAL SUMMARY

At the time of his death in 1899, Marsh had projected a series of US Geological Survey monographs on several suborders of dinosaurs. A large numbers of plates and woodcuts had been completed for these monographs, but little of the texts. H.F. Osborn, who succeeded Marsh as vertebrate paleontologist for the Survey, assigned the task of completing these monographs to several dinosaur scholars. Osborn assumed task of working on the sauropods. In 1902, five years after the death of Cope, the American Museum of Natural History in New York obtained the partially prepared Cope dinosaur collection. Osborn oversaw the final preparation and cataloguing of sauropod material. He was assisted in its study by C.C. Mook.

Major discoveries of sauropod dinosaurs were made in 1909 in what is now Dinosaur National Monument in Utah by Carnegie Museum parties. Realizing that completion of the sauropod monograph would have to be postponed for many years, Osborn and Mook decided to publish their study of the Cope Garden Park material (Osborn and Mook, 1921). In this monograph (p. 255) they state, "Unfortunately the quarry records of the Cope Cañon City material have been lost. Two large quarries are known to have existed, and their location is known at the present time." They proceed to give the location of Cope Quarry Number 1 from which bones catalogued AMNH 5760 were believed to have been collected by O.W. Lucas

in 1877. These include bones of the "Red Series" so named from their color. Next, they locate Cope Quarry Number 2 from which bones catalogued AMNH 5761 were believed to have been collected by I.H. Lucas in 1880. From their color, these bones were said to belong to the "Yellow Series." Osborn and Mook add that there may have been a third quarry from which the *Amphicoelias* material was derived, but that nothing was known of its nature or location. They also describe how after the arrival of the Cope collection in New York in 1904, W.D. Matthew, under Osborn's supervision, catalogued the material as best he could. Then W.K. Gregory and Osborn attempted to arrange the vertebrae of *Camarasaurus* sequentially into provisional series based in part on bone color. Their conclusions were subsequently modified by Mook under Osborn's direction: "Intermingled are the remains of four more or less complete individuals and parts of at least two additional ones... But from the total *deficiency of field records* [italics mine] it is impossible to connect them up or to be certain that either series may not belong to the fifth or sixth individual" (Osborn and Mook, p. 260).

It is not surprising that without direct evidence Osborn and Mook were erroneous in their estimate of 13 cervicals, 10 dorsals and one dorso-sacral in the presacral vertebral count of *Camarasaurus*. It is ironic that at the time of publication of their exhaustive monograph, several articulated vertebral columns of *Camarasaurus* had already been collected by the Carnegie Museum and were being prepared. Four years later, C.W. Gilmore (1925) was able to correct the presacral vertebral count to 12 cervicals, 12 dorsals and 1 dorso-sacral. Because the Osborn and Mook monograph had described the Cope material in fine detail with multi-viewed figures of virtually every bone (except the right ribs), it is not surprising that no one thought it necessary in the intervening 70+ years to study the collection further. Thus, I was surprised, several years ago, in an attempt to clear up several minor questions, that I discovered some "mysterious" letters and numbers written on the bones assigned to AMNH 5761. In an attempt to understand these markings, I searched the archives of the American Museum of Natural History Department of Vertebrate Paleontology and to my astonishment found that Osborn and Mook's statement concerning "a total deficiency of field records" was less than accurate. Five letters from O.W. Lucas and four from I.H. Lucas had survived, and they provide considerable information (see below). Even more astonishing was the discovery of a small pocket notebook used by Cope during his visit to Garden Park in July 1879. In it, with the help of O.W. Lucas, Cope had drawn a rough map of the area, showing not two or three quarries, but seventeen, with an

indication that others were located several miles away. Furthermore, this map showed that quarry CS2 (*Camarasaurus supremus* Number 2 of Lucas = AMNH 5761) lay to the west of CSI (*Camarasaurus supremus* Number 1 of Lucas = AMNH 5760) in contradistinction to their locations indicated by Osborn and Mook (1921, p. 253).

Further information about the Cope quarries was obtained from a most unlikely source – two letters sent to Marsh in August 1877 by his collector B.F. Mudge. Mudge had been sent to Cañon City to try to obtain Lucas's material, but it had already been sold to Cope. He did, however, get to see many of the bones at the railroad station ready to be shipped (see more below). Still more information was gleaned from the shipping records made by Matthew when he supervised the transfer of the Cope Collection from Philadelphia to New York. When all this information is combined with that provided by Cope in his papers, a much more detailed picture of the Garden Park collection emerges, and errors in the Osborn–Mook monograph can be corrected. Thus, instead of one shipment in 1877 shipment by O.W. Lucas and another in 1880 by his brother I.H. Lucas, at least seventeen shipments were made from the summer of 1877 through January 1884. All of the Cope dinosaur type specimens were sent in shipments from O.W. Lucas, who had also collected the greater part of "*Camarasaurus* Number 2" in 1878. In a letter to Cope dated February 10, 1879, he provided an inventory of those bones which had already been removed from the ground. He also listed a number of others which had been only partially excavated. Using all these data, I have been able to reconstruct with considerable detail and accuracy a record of precisely which bones were sent in each box of the last seven shipments, and to detail much useful information concerning the first ten shipments as well.

CHRONOLOGY OF THE SHIPMENTS FROM GARDEN PARK

The first eleven shipments to Cope were sent by O.W. Lucas between 1877 and 1879. He assigned each animal from a given quarry a separate number – Fossil 1 to Fossil 10 – and each bone a separate letter. Most of the bones were collected in a number of pieces, the breaks being marked by crossing hatch marks to enable the preparators to restore them more easily. In the first five shipments, he numbered the boxes of each "Fossil" separately and serially, e.g. in shipment ⟨5⟩, Fossil 1, boxes 20–24, Fossil 8, boxes 1–8 etc. In shipment seven to ten, the boxes were simply labeled 25 to 70 with different "Fossils" in the same box.

Shipments 1 to 10 of O.W. Lucas

⟨1⟩ small box sent and received in the summer of 1877.
Contents: right dentary and eight teeth of "Fossil 2" described by Cope, 1877a, published August 15, as *Laelaps trihedrodon*, sp. nov. Only the teeth are now available, AMNH 5780.

⟨2⟩ sent and received in the summer of 1877, shortly after.
Contents: one cervical two dorsals, and three caudals of "Fossil 1" described by Cope, 1877b, published August 23, as *Camarasaurus supremus*, gen. et. sp. nov., AMNH 5760.

⟨3⟩ sent shortly after ⟨2⟩, reported in M.P. Felch's letters to Marsh, dated August 12 and 15.
Contents: dorsals and caudals, sacrum of four vertebrae, chevron, scapula, pelvic bones, a six foot (1.8 m) long femur. Box list lost, but ⟨2⟩ and ⟨3⟩ together contained freight boxes 1 to 17 of Fossil 1, *Camarasaurus supremus*, AMNH 5760 (Cope, 1877d; 1878a).

⟨4⟩ sent October 21, 1877 (letter of O.W. Lucas).
Contents: (a) more unspecified bones in boxes 18 and 19 of Fossil 1, *C. supremus*, AMNH 5760; (b) boxes 1 to 4 of "Fossil 8" (A. Ripley's Fossil): dorsal vertebrae number "1" and "4", two ribs, a femur and a pelvic bone [pubis], described by Cope, 1877c as *Amphicoelias altus*, gen. et. sp. nov.
Comments: Lucas wrote, "The above vertebrae and ribs are numbered 1, 2, 3 etc. commencing somewhere near the sacrum and going toward the anterior end of the animal." Cope's map locates the site of "lot XII" and states that, "The skeleton ran into the bank head first, and the anterior part of the head can probably be obtained". More of this below.

⟨5⟩ sent October 22, 1877 (O.W. Lucas, letter).
Contents: (a) Boxes 20 to 24 of "Fossil 1", *C. supremus*, containing a scapula, a coracoid, a pelvic bone, a "lumbar vertebra", several ribs, a chevron and three caudals. (b) Box 1 of "Fossil 2" *Laelaps trihedrodon* contained "fragments of the head found not far from the jaw sent in the first shipment"; specimen no longer available. (c) Boxes 1 and 2 of "Fossil 10", specimens no longer available.

⟨6⟩ small box sent by express and received October 31, 1877 (Cope letter to Lucas).
Contents: fragmentary types of three new animals (Cope, 1877c) published November 21: (a) teeth *of Caulodon diversidens* AMNH 5768; (b) "Fossil 3" *Tichosteus lucasanus*, AMNH 5770; (c) turtle *Compsemys plicatulus*.

Comments: The box number was apparently 25. This and future boxes discontinued using separate box numbers for each "Fossil".

⟨7⟩ small box sent ahead by express, numbered 46 of a much larger freight shipment, received in December 1877.

Contents: fragmentary types of two new animals (Cope, 1878a), (a) *Symphyrophus musculosus*, AMNH 5772; (b) *Caulodon leptoganus*, AMNH 5769. The latter originally consisted of three or four teeth "from a locality distant from that in which *C. diversidens* was derived" (Cope, 1878a), elsewhere stated to be "near the old diggings from the same place as Fossil 1."

⟨8⟩ sent by freight on January 6, 1878 (O.W. Lucas letter with detailed box list).

Contents: boxes 26 to 45 containing (a) "Fossil 1" *Camarasaurus supremus*, AMNH 5760, a small and a large cervical, six dorsals in sequences, 20+ ribs, some connected to the dorsals, 30+ caudals, several chevrons; (b) "Fossil 2" *Laelaps trihedrodon*, a femur and some fragments (no longer available).

Comments: Since this shipment was not sent until January of 1878, it was not available to Cope on December 21, 1877, when he delivered his major paper (Cope, 1878a) on *Camarasaurus* and *Amphicoelias* before the American Philosophical Society. The femur of "Fossil 2" is no doubt the one referred to by Cope (1878b,c,d) in his papers on *Hypsirhophus discurus*, where he mistakenly suggested that it "may be the same species as *Laelaps trihedrodon*" and added, "The femur of this species has very nearly the characters of that of *Megalosaurus bucklandi* and is quite different from that of *Laelaps*; hence if not a *Hypsirhophus*, the *Laelaps trihedrodon* must be referred to *Megalosaurus*". The femur has been lost and all that remains of *Hypsirhophus discurus* is a stegosaur dorsal and caudal, AMNH 5731.

⟨9⟩ sent by freight in the spring or early summer of 1878.

Contents: Boxes 47–54. The records of this shipment have been lost unfortunately, because they may have contained information concerning the giant dorsal vertebra, AMNH 5777, now lost, named *Amphicoelias fragillimus* (Cope, 1878e) (see below).

⟨10⟩ sent August 28, 1878 (O.W. Lucas letter with box inventory). These records have suffered water damage, some in crucial places.

Contents and Comments: Belonging to "Fossil 1", *Camarasaurus supremus*, AMNH 5760, there are half of a cervical (probably AMNH 5760/X-c-4), two dorsals, 20+ caudals, 11+ ribs, a sternal

and a tibia and a fibula "by the bed of *Camarasaurus supremus*" (probably AMNH 5760/Tb-3 and AMNH 5760/Fb-2.

In addition, there are a number of bones supposedly belonging to *Amphicoelias*, but the data on the sites from which some of them were taken are obscured by water damage. For example, box 60 contained "S, ulna of *Amphicoelias altus*. [location obscured]". This is no doubt the ulna provisionally referred to this species by Osborn and Mook. Its outright reference to *A. altus* by Lucas suggests that it came from the type locality, but the damaged field records leave this conclusion uncertain. Box 60 also contained "G, pubis of *Amphicoelias*, somewhat poor," and box 67 contained "1/2 pubis of *Amphicoelias*. Could the first be AMNH 5760 referred by Osborn and Mook to *Camarasaurus*, or could Pb-3 either of these be Pb-6, a bone catalogued 5761, but which lacks the box information that is usually painted on bones of the second group of shipments ⟨11⟩ to ⟨17⟩? This incomplete pubis could indeed, belong to *Amphicoelias*, but not to the type specimen, because both bones are from the left side.

Box 64 contained "1/3 of a very large femur. Is it *Amphicoelias fragillimus*"? This might be the incomplete left femur referred by Osborn and Mook (1921) to *A. altus*, AMNH 5764a. Box 64 was also supposed to contain a number of bones and pieces of *Hypsirhophus*", and box 65 "a dorsal of *Epanterias*", in all probability that shown in figure 26 of Osborn and Mook (1921). Its positive identification by Lucas suggests that it came from the type quarry and was therefore likely part of the type specimen. There are further references to limb bones that do not now exist in the American Museum collection. For example, box 63 was said to contain a "good 1/2 femur" of *Camarasaurus supremus* and box 67 one-third of a leg bone not further identified.

Later Shipments

It was the later shipments, particularly numbers ⟨11⟩ to ⟨14⟩ that were to provide the most information. After the summer of 1878, O.W. Lucas traveled east to continue his education at Oberlin College in Ohio. From there, he wrote a letter to Cope, dated February 10, 1879, in which he gave a list of bones that were either out of the ground, or partially so, of what was believed to be a skeleton of "*Camarasaurus* – 2". The quarry was a quarter of a mile distant from that of "*Camarasaurus* Number 1", which was

thought at the time to be a single individual. Lucas informed Cope that he intended to work through an agent in completing the disinterment of this animal. Returning to Cañon City the following summer, Lucas packed and sent to Philadelphia a large shipment, number ⟨11⟩, of the bones of this new animal in a new series of boxes numbered 1 to 18. They were probably sent some time in the early summer of 1879.

The box inventory of this shipment has not been found, but by a quirk of fate, it has been possible to completely reconstruct it. Cope had his preparator, Jacob Geismar, completely clean and restore the bones from the first ten shipments. Already possessing the greater part of one gigantic camarasaur skeleton, and learning that Number 2 *contained no limb material*, the parts most needed to supplement Number 1, Cope decided to sell Number 2. Therefore, he did not open any of the boxes of shipment ⟨11⟩ nor of later shipments ⟨12⟩ to ⟨14⟩, which also contained bones of Number 2. Thus the boxes of each shipment were kept together in separate piles in the basement of Cope's home. There they remained together with field numbers and intact until they were transferred to New York to be opened and prepared.

In the process of the move, Matthew renumbered serially all the boxes in the entire Cope collection. When the preparators finished each bone they dutifully recorded on each, in addition to the catalogue number, Lucas's original box number, Matthew's shipping box number, and the bone letter, e.g., B5, box 156 and J for the right pubis catalogued AMNH 5761/Pb-1. By noting this information on each bone, it has been possible to restore the box inventory of shipment completely.

When O.W. Lucas returned to Garden Park for the last time in the summer of 1879, he completed the removal of the material listed as "partly out of the ground" in his letter of February 10. He was also able to meet Cope personally for the first time on July 26 during the latter's western trip of 1879. At that time, Lucas was able to show him the various quarries ("lots") from which the different specimens had been taken. Cope recorded this information in a map in his pocket notebook as discussed further below. Lucas also arranged to have his brother Ira H. Lucas act as his agent in completing the collection and shipment of the rest of *Camarasaurus* Number 2.

I.H. Lucas made his first shipment, number ⟨12⟩, on January 27, 1880, and the box inventory has been preserved. Table I is a complete list of the bones given in O.W. Lucas' letter of February 10 against the complete list of bones packed in shipments ⟨11⟩ and ⟨12⟩.

The agreement between Lucas' list and the reconstructed inventory, even to the exact number of caudals, is striking. The apparent removal during

TABLE I Comparison of the specimens listed in Lucas' letter to Cope of February 10, 1879, and that reconstructed for shipments ⟨11⟩ and ⟨12⟩

Lucas' List	*Inventory of Shipments* ⟨11⟩ *and* ⟨12⟩
	brain case
part of "lower" jaw with teeth	maxilla with teeth
axis with 2 cervicals, 1 not fully excavated.	6 cervicals
6 dorsals and 6 or 7 more not yet excavated	12 dorsals and 1 dorso-sacra
many ribs	11 left ribs, 12 right ribs, 5 fragments
33 caudals	33 caudals
	6 chevrons
left and right scapula, only 1 excavated	left and right scapula
coracoid	sternal plate
left and right ilia	left and right ilia
left and right pubes	left and right pubes
left and right ischia and one extra one!	left and right ischia
	right tibia
	right fibula
	right astragalus

the summer of the scapula, seven dorsals, several more cervicals and the brain case suggests that Lucas may have been dealing with a semi-articulated skeleton taken up from rear to fore (more of this later). What is most intriguing, is the presence of the three limb elements, AMNH 5761/Tb-1, 5761/Fb-1, 5761/As-1, almost certainly belonging to the right hind limb of a single individual. Lucas' list of February 10th contains no limb elements and Cope's pocket notebook written in late July specifically stated *no limbs*. All three elements were sent in shipment number ⟨11⟩. Were they collected in the late summer or autumn of 1879 before shipment ⟨12⟩ was sent, or were they left over bones from an earlier time that did not belong to *Camarasaurus* Number 2? This question cannot be answered with certainty without the missing records from shipment ⟨11⟩. I shall return to this problem later in an attempt to unravel the several individuals catalogued under AMNH 5761.

The records from shipments ⟨13⟩ and ⟨14⟩ are also missing, so it is not possible to be sure when they were sent. It seems probable to me, however, that they were shipped at the end of the 1880 and 1881 collecting seasons respectively. We know from Matthew's records that ⟨13⟩ contained boxes 31 to 37 and ⟨14⟩ boxes 38 to 50. It has also been possible to restore many of the box inventories of each of these shipments. In ⟨14⟩, however, some of the box information has been rubbed off the bones, so it is not certain in which box several of the bones were sent.

The work of 1880 and 1881 involved more than one individual of sauropods. Indeed, in a letter dated July 18, 1881, Ira Lucas wrote of another specimen "that without doubt belongs to some other animal than *Camarasaurus* Number 2. There are a pair of scapulas, an ischium, and cervical vertebrae. They [the cervicals] are somewhat different from Number 2 in having longer centra. I think you have a right to all of these, and I will put them into you just the same as Number 2." A number of boxes shipment ⟨14⟩ are marked B – *to 3*, apparently meaning that the bones in these boxes belonged to this third individual. The numbering of these boxes "to 3" continues in sequence from those of *Camarasaurus* Number 2. This causes me to wonder whether they were derived from the same quarry.

The bones of *Camarasaurus* Number 2 soon ran out early in the 1882 season and I.H. Lucas tried two other sites. Bones from this season were sent in shipment ⟨15⟩ on April 16, 1883. His inventory and comments on them have been preserved. They include 7 boxes, the first three of which, numbers 1 to 3 in a new numbering scheme came from the "Oil Claim". This area had been mentioned in Cope's notebook as producing the type femur (and presumably the four caudals as well) of *Amphicoelias latus*, a species shown by Osborn and Mook (1921) to be a synonym of *Camarasaurus supremus*. Further information concerning this site is provided by Marsh's collector in Garden Park, M.P. Felch, who in a letter to his employer dated March 8, 1883 stated "Lucas worked last summer two miles below my place in the hills on the east side of the creek, Oil Creek [also known as Four Mile Creek]."

Included in these three boxes are five vertebrae and two limb bones, two supposed foot elements, and a scapula. Two boxes contained bones of "A. Ripley fossil" i.e. *Amphicoelias altus*, including five badly damaged vertebrae and a well preserved humerus AMNH 5761/H-1. Two other boxes contained the last four bones from *Camarasaurus* Number 2, a good cervical, two badly broken ones and a rib. Later in 1883, three more boxes, numbers 8 to 16 were sent in shipment ⟨16⟩ but nothing is known of them.

Ira H. Lucas's final year of work in Garden Park was 1883. He worked south of Saurian Hill, i.e., the "Nipple" (Fig. 1) near the north end of a fort" (i.e. butte) where "brother took out several good bones of *Amphicoelias*". In a letter dated October 13, Ira Lucas described the year's work and provided an inventory of the 29 bones collected and placed in boxes 11 to 18. These were eventually shipped to Philadelphia on January 16, 1884 (shipment ⟨17⟩). From a study of the American Museum Cope collection it became clear that many of the bones in the later shipments ⟨15⟩ to ⟨17⟩

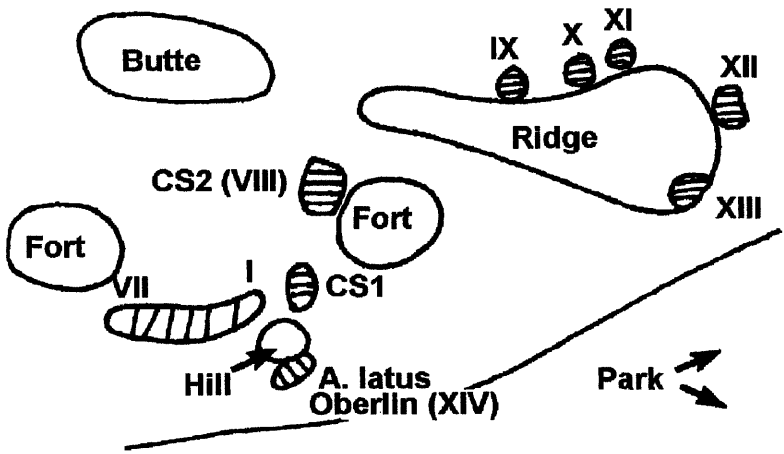

FIGURE 1 Redrawing of the map sketched by Cope of Saurian Hill and quarries in the vicinity. CS1 and CS2 are the quarries of *Camarasaurus supremus* 1 and 2 respectively. "Hill" is the Saurian Hill of Cope's notes = The Nipple of Osborn and Mook (1921). Park refers to Garden Park beneath the escarpment.

were missing. Indeed, ⟨17⟩ contained a femur and several pelvic bones, large elements not easily lost.

A probable solution of the missing bones was presented by Spamer and Forster (1988) who stated that the Wagner Free Institute of Science in Philadelphia had purchased a series of sauropod bones from Cope in 1891, "composed of a pelvis, both femora, and 3 anterior caudal vertebrae." They were from Cañon City, Colorado and "The Institute's accession book records the following data about the Cope Specimen 1891 4123 *Camarasaurus supremus*. Col. E.D. Cope." The bones, 2 right femora, a right pubis, an incomplete right ischium, two and one half interlocked dorsal or sacral centra, a median caudal, fragments of a ?scapula and three segments of a dorsal, are on exhibition at the Institute as those of *Apatosaurus excelsus*. The limb and pelvic bones are clearly those of *Camarasaurus*. Although no further records exist, it appears that most of these bones came in ⟨17⟩, but the possibility exists that some were sent to Cope by Lambuth, an independent fossil collector in Cañon City. On the assumption that these bones came in ⟨17⟩ the femur would be bone 10, which was contained in boxes xii and xvii; the pubis, bone 4, in box xiii; the ischium, bone 17, in box xiv and the "part of sacrum", bone 13, in box xiv. Various vertebrae were sent in boxes xi to xvii, but they cannot be positively identified with those mentioned above.

Where the second femur at the Institute came from is not known, but it is not unlikely that it was sent in shipment ⟨16⟩ the records of which have been lost. The femora and pelvic bones are well preserved, but do not add much to our knowledge except to fill a gap concerning the disposition of Cope's sauropod collection.

Most of the boxes in the later shipments were not those of *Camarasaurus* Number 2, which Cope wished to sell, so they were opened in Philadelphia. Because many of these bones were badly preserved, it is likely that much of the material still not accounted for was discarded. The poor bone quality is the reason that Cope terminated the Garden Park work at the close of the 1883 season.

THE COPE MAP AND COMMENTS TAKEN FROM HIS NOTEBOOK

The map from Cope's notebook referred to above is reproduced below (Fig. 1). I include a transcription of the notes accompanying it made during his visit to Garden Park in July, 1879 (see also Monaco, this volume).

> "Location of Saurians in the Jurassic of Canyon City, south side of Saurian Hill [now known as 'The Nipple'].
>
> I. 200 yards from locality of *Camarasaurus supremus* CS 1; were found the cervical of *Morosaurus laticollis* and jaw of *Hypsirhophus trihedrodon* in a radius of 20 feet. Centrum of *Amphicoelias altus*.
> II. *Epanterias* vertebra. One of *Camarasaurus leptodirus*. axis of ?? and femur of *Hypsirhophus* (good) with nice ribs hard and rather small; all from a radius of 20 feet; ten feet from lot I.
> III. *Amphicoelias fragillimus* from between the two lots.
> IV. Immense distal end of femur near first broken smaller femur.
> V. Another *Camarasaurus* not yet out.
> VI. Femora.
> VII. Dorsals of *Amphicoelias* with caudals; a broken sacrum, a pubis broken sacrum, a pubis broken and a good dorsal of *Camarasaurus*; a cervical of the same.
> VIII. 1/4 north on the same horizon is a second *Camarasaurus* [CS 2] this much like the type; the skeleton very complete lacking limbs.
> On the same horizon around a ridge we have my 160 acres, on north-west side are three localities of large bones IX, X, XI not very good.

XII. Is the original *Amphicoelias altus*. This runs into the bank head first and the anterior part and the head can probably be obtained.
XIII. A few bones not very good.
XIV. *Amphicoelias latus* femur from near *Camarasaurus supremus* CS 1 is in Oberlin. My femur came from Oil Tract one or two miles from the above locality from a bed of sandstone near the same horizon. The horizon of these bones is nearly identical and is 500 feet above the red beds in bluish and lead colored marls or white sandstone below a bed of sandstone about fifty feet.
XV. ??Humerus in sections with a large piece of centrum of caudal vertebra, upper end of long bone in oval section 5″ short diameter, from Oil Tract a mile below *A. latus* locality.

REASSESSMENT OF COPE'S SAUROPODS

Camarasaurus supremus Number 1, AMNH 5760

Osborn and Mook (1921) showed that this material represents two or more individuals. An attempt to separate the individuals is postponed to a future paper. For the present, the six vertebrae sent in shipment ⟨2⟩ continue to be accepted as the type specimen. Osborn and Mook's (1921) statement that the bones of AMNH 5760 are reddish-brown and belong to the RED series is only partially correct. Many of them are also yellow but a deeper yellow (almost golden) than those of AMNH 5761. The great femur, AMNH 5761a/Fem-1, should be transferred from AMNH 5761a to AMNH 5760. It bears none of the box or bone numbers of *Camarasaurus* 2. It is clearly the "1.820 meter" long femur with one side of the shaft damaged so that the form of its section cannot be ascertained" (Cope, 1878a). Its yellowish color and general proportions suggests that it belongs to the same limb as AMNH 5760/Tb-2.

Cervical AMNH 5760/X-c-4 must be removed from AMNH 5760 because it was not collected in Quarry CS1 but in lot I of Cope's map. It was referred to *Morosaurus laticollis*, no doubt on account of its similarity to a published figure of a cervical of *Apatosaurus laticollis* (Marsh, 1879). This vertebra clearly belongs to *Apatosaurus*. Cervical AMNH must be removed from AMNH 5761a and placed in AMNH 5760. It was sent in box 44 of shipment ⟨8⟩, one of the few CS1 boxes never opened by Cope's preparators. Dorsal AMNH should likewise be transferred from AMNH 5761 to AMNH 5760 because it was sent in box 27 of shipment ⟨8⟩ the other CS1 box never opened by Cope.

Chevron 24 came in the same box but is listed in Osborn and Mook (1921) in one place as AMNH 5760′, in another as AMNH 5761; AMNH 5760 is correct. Chevron series 1 of Osborn and Mook (1921) are all marked AMNH 5760′ in their figure 62, but some are actually AMNH 5761. These are correctly identified in the table on page 330 of that memoir. A number of ribs listed as AMNH 5760′ should be transferred to AMNH 5761. These are R-a-6, R-a-9, R-a-16, R-a-27, R-a-29, R-a-34, and R-a-39.

Lastly, the number AMNH 5761, not AMNH 5760′ is written on fragmentary ischium Is-8, but there are no other markings on this bone. Is-7 and Is-8 may have been confused by Osborn and Mook and Is-7 may belong to AMNH 5760.

These are all the corrections to Osborn and Mook that can be made with certainty, although it is possible that some of the few elements referred to AMNH 5761 with no box or bone number painted on them may belong to AMNH 5760. It is also possible that, like AMNH 5760/X-c-4 cited above, some of the bones prepared in Philadelphia and assigned by cataloguers in New York to AMNH 5760 came from neither from quarry CS1 or CS2. After the above corrections, AMNH 5760 comprises:

2 cervicals
18 dorsals including 1 dorso-sacral
55 caudals
17 left ribs and an undetermined number of right ones.
8 chevrons
a right scapula
a right coracoid
a partial left ilium
a left and a right pubis belonging to different individuals
a left and a right ischium probably belonging to the same individual
a second set of ischia
a left femur and a right tibia belonging to different individuals
a right fibula.

There is nothing to suggest more than two individuals of almost the same size.

One curious point remains. In his December 1877 address, Cope (1878a) listed the bones of *Camarasaurus supremus* [AMNH 5760] received up to that time as one cervical, 20 dorsals and lumbars, half a sacrum, 20 caudals, both scapulae, both coracoids, two pairs of pelvic bones – ilia and pubes – a femur, a tibia, and a metapodial. How did he obtain 20 dorsals, when

the total number shipped is known to be 18, including six in shipment ⟨8⟩, which was not shipped from Cañon City until January 6, 1878. Perhaps O.W. Lucas had informed him in a letter of additional vertebrae to come. The presence of a second scapula and a second coracoid is possibly explained by the inclusion of the scapula and coracoid assigned by Osborn and Mook (1921) to ?*Amphicoelias altus* AMNH 5764a.

Much harder to explain is the current loss of the sacrum. It cannot have been misidentified because its description is clear (Cope, 1878a). That the well preserved sacrum of AMNH 5761 might actually be that of AMNH 5760 is ruled out because the box number on this sacrum clearly identifies as having come from CS2 and having arrived in Philadelphia in shipment ⟨11⟩. O.W. Lucas's letter of February 10, 1879 states that a complete sacrum was present in *Camarasaurus* Number 2. Also missing are the second ilium and the metapodial.

In summary, the new information concerning "*Camarasaurus supremus* Number 1" is meager. Separating the elements of the two individuals, a task reserved for a later paper, will be difficult unless more of the original field records are recovered. Any such attempt would presumably be based on color differences and the less constraining knowledge that the dorsal series contained 12 rather than 10 vertebrae.

Camarasaurus supremus Number 2, AMNH 5761

New information concerning this material permits removal of several elements from AMNH 5761. These include femur Fem-1, cervical X-b-5, dorsal D-x-130 and another undesignated one, caudal Cd-x-19, rib R-a-38, humeri H-1 and H-2, metacarpal Mtp-1, right ilium 11-4, and left tibia Tb-4, all of which came from other quarries than CS2. The two humeri are markedly more robust than those of *Camarasaurus grandis*, *C. lentus* and *C.* (= *Cathetosaurus*) *lewisi*. The right humerus is positively identified in Ira Lucas's notes of April 16, 1883, from a drawing and from measurements as that sent in shipment ⟨15⟩. It was supposed to have been part of "A. Ripley's Fossil" (the type skeleton of *Amphicoelias altus*, AMNH 5764). As stated above, this humerus is here assigned to *Apatosaurus*. The other humerus, H-2, which also did not come from CS-2, was sent in shipment ⟨16⟩, from an unknown site, possibly the same one as H-1. It is from the opposite side of the body, but closely resembles H-1, and is thus also referred to *Apatosaurus*. The foot bone, Mtp-1, identified by Osborn and Mook (1921) as a left metacarpal II, was also sent in shipment ⟨15⟩. It is probably bone 14 sent in box 2 from the Oil Claim. The lower half of the

right tibia, Tb-4, was sent in the same box and is probably bone 13. Also in shipment ⟨15⟩, was right ilium Il-1.

With the removal of all these bones from AMNH 5761, I consider the possibility of separating the two (or perhaps three) individuals still contained in this catalogue number. This problem is far more than an intellectual exercise, for if it can be resolved, it may be useful in diagnosing the various species of *Camarasaurus*. The overall problem will probably not be completely resolved until articulated skeletons with skulls are available for each of the currently recognized species. Until then, differentiation must continue to depend on such criteria as minor differences in the vertebrae and limb bone ratios. For example, the dorsal arches of *C. grandis* are placed on high pedicels in contrast to those of other species. In *C. lewisi*, the divided neural spines of the dorsal vertebrae persist almost back to the sacrum instead of only halfway as in other species.

O.W. Lucas believed that *Camarasaurus* Number 2 represented a single individual with a single stray ischium. Except for the ischium, the comparison of his inventory with that of shipments ⟨11⟩ and ⟨12⟩ also support only a single animal. The missing records of ⟨13⟩, where the inclusion of too many dorsals indicates that more than one individual, muddies the picture. Although the box inventory has been reconstituted, it does not tell us whether the separation in the quarry of two assemblies of bones indicated two individuals. If my assumption that collecting proceeded from the tail forward, it may be assumed that at least some of the seven cervicals sent in ⟨13⟩ belonged to the original skeleton. Before an attempt is made to deal with this question, some preliminary matters concerning shipments ⟨11⟩ to ⟨13⟩ must be clarified.

(A). The first problem concerns the right tibia Tb-1, fibula Fb-1, and astragalus As-1, sent in boxes 1, 2, and 13, respectively, of shipment ⟨11⟩. It has already been noted that as late as July 25, 1879, no limbs had been found with *Camarasaurus* Number 2. Since the tibia, fibula, and astragalus appear to belong to *Camarasaurus*, have the correct proportions with the pelvic elements of a single individual, and have the same yellowish gray color, it is not unreasonable to assume that they must have been uncovered during the last month of collecting and do, indeed, belong to this animal. The tibia and fibula also bear O.W. Lucas's letter C and D in the same series as the left and right ilia N and M, left and right pubis L and J, and left and right ischia K and Z. Finally, although Lucas' list includes a third ischium, no such bone is found in any of the boxes of ⟨11⟩ or ⟨12⟩.

(B). The second problem has to do with the question of a supposed *Camarasaurus* Number 3. Starting with his shipments from ⟨12⟩ through

⟨14⟩ and into ⟨15⟩, I.H. Lucas, instead of using letters for the individual bones, used numbers 1 through 65 for vertebrae and girdle bones (there being no limb bones), and letters for the ribs and chevrons. Seven of the boxes in shipment ⟨14⟩ were labeled with "-to 3", e.g., B39 -to 3, B40 -to 3 etc. This notation was mystifying until a close reading of I.H. Lucas's letter of July 18, 1881 suggested a third *Camarasaurus*.

If my interpretation is correct, other questions arise. Did *Camarasaurus* Number 3 come from the same quarry (CS 2) as Number 2, and if so was it isolated from Number 2 or intermingled with it? On the other hand, if from a distinct quarry might it be from "lot V" of Cope's map which was supposed to contain "another *Camarasaurus* not yet out?" Perhaps the latter alternative is correct, but if so, why did I.H. Lucas continue numbering the bones from the two quarries in sequence? In either case, when the bones from the "-to 3" boxes are separated from the rest of AMNH 5761, there are still two individuals represented in the remaining elements. A further ambiguity occurs in this connection since Matthew's shipping list shows 225-B45 to 3, whereas the individual bones from this box show 225-B 45 without a "-to 3".

(C). A third problem, albeit a minor one, involves some bones marked AMNH 5761 but bearing no further information. In this category are two dorsals, a caudal, a left sternal plate St-2, a very fragmentary ilium Il-5, an incomplete pubis Pb-6, an ischium Is-7, the small femur Fe-2, metapodial 3 (metatarsal II of Osborn and Mook, 1921), 6 chevrons, and one left and one right rib. Many of these problem bones probably came from the later shipments ⟨15⟩ to ⟨17⟩ and cannot now be identified because of incomplete shipping lists. Some of these boxes were opened by Cope and repacked. The color of femur Fem-2 indicates that it almost certainly did not come from Quarry CS2. Likewise the metapodial is almost surely not *Camarasaurus*. On the other hand the chevrons may well have come from Quarry CS2 as they have the right color, and some from this quarry were not even lettered by I.H. Lucas. The sternal plate may be the mate of St-1 sent in box 13 (175 of Matthew) of ⟨11⟩ (probably the bone misidentified as a coracoid in O.W. Lucas's letter of February 10, 1879). The ischium probably belongs to *Camarasaurus*, while the pubis may or may not as discussed elsewhere.

What, then, are the prospects of separating the individuals catalogued together as AMNH 5761? On the encouraging side is the fact that ⟨11⟩ and ⟨12⟩ contain the correct number of dorsals, dorsal ribs, sacrals, and caudals with apparently no duplication (even of the ischium) of the girdle and limb bones. Furthermore, when illustrations of the 33 caudals in ⟨11⟩ and ⟨12⟩ are placed sequentially, it appears possible that they might belong to

a single tail. The first 14 bear transverse processes as they should for *Camarasaurus*. A number of the vertebrae have suffered from crushing, and the actual bones would have to aligned and studied to determine if they belonged to a single individual. The same is true of the 12 dorsals, the dorso-sacral, and of the ribs. More difficult would be the problem of separating the cervicals.

Amphicoelias altus AMNH 5764

It is now known that this specimen was found by A. Ripley in "lot XII" of Cope's map and was dispatched to Philadelphia by O.W. Lucas in four boxes of shipment ⟨4⟩ on October 21, 1877. Since it took approximately a month for freight shipments to arrive from the West, it is remarkable that Cope's first paper describing this animal was published on December 10 (Cope, 1877a), an example of the speed engendered by the rivalry with Marsh. The box inventory of ⟨10⟩ sent August 28, 1878, contains a number of bones referred to *Amphicoelias*. Some of the bones had specifics as to which quarry they came from, but clearly not all were from the type locality. Thus, references in the box inventory of a "pubis G. poor" in box 60, "a vertebra in box 63 of *Amphicoelias altus* from the bed of *Camarasaurus supremus*", "1/3 of a very large femur" in box 64 that Lucas wondered if it belonged to *Amphicoelias fragillimus*, and half of a pubis of *Amphicoelias* sp., are all probably based on identifications from copies Cope's papers sent to Lucas.

The identification of half a scapula of *Amphicoelias*? is based on its being found with the femur mentioned above. On the other hand, the identification of ulna S in box 6 as *Amphicoelias altus* is more interesting because no other fore limb bones had been found in any of the Garden Park quarries up to that time. The rest of the information of this bone is blurred by water damage, and there are doubts of its provenance. Nevertheless, there is the strong implication that the only justification Lucas had for its positive identification was that it came from the type locality, "lot XII". Indeed, Osborn and Mook (1921) referred this ulna to the slender limbed *Amphicoelias*, rather than to *Camarasaurus*, Humerus H-1 is known specifically to have come from the A. Ripley site in 1882. The "five vertebrae badly decayed and several parts of ribs" found and sent with the humerus, were apparently too badly preserved to be of any value and were no doubt discarded in Philadelphia or New York. The fact that the humerus appears to belong to *Apatosaurus* suggests that several animals were present in lot XII. The ratio of the length of the humerus to the

length of the femur, AMNH 5764/Fem-3, is 0.64, not unreasonable for a diplodocid. However, that *Amphicoelias* should have a very slender femur and a rather stout humerus appears unlikely. Also, the ulna cannot have belonged to the same limb as the humerus since the ulna/humerus length ratio is 0.92. Furthermore, the ulna/femur length ratio of 0.6 appears to be completely out of the question for an individual (0.45 to 0.50 is more usual in diplodocids).

Although it appears that several individuals were present in lot XII, the intriguing possibility remains that *Amphicoelias*, whose dorsals appear to differ from those of *Diplodocus*, represented the ultimate development of the shortening of the fore limb in the Diplodocidae. Finally there is the suggestion from Cope's notes that more of the type skeleton of *A. altus* remains to be collected if lot XII can be located precisely. K. Carpenter and E. Evanoff are attempting to do just that.

Amphicoelias latus, AMNH 5765

Osborn and Mook (1921) have synonymized this species with *Camarasaurus supremus*. Only two of the caudals were identified by them. The other two may be among those now catalogued as AMNH 5760, or they may have been lost. The only new information on this specimen is that it came from the "Oil Tract", one or two miles from CS1. My attempt to locate the *A. latus* femur from lot XIV at Oberlin College proved fruitless. It apparently no longer exists.

Apatosaurus. Osborn and Mook (1921) did not recognize the presence of *Apatosaurus* among the Cope specimens, but not surprisingly, this common Morrison genus is represented in the collections by several specimens. The first is cervical X-c-4 referred to *Camarasaurus supremus* in figure 35 of the Osborn and Mook monograph. The very massive, downwardly directed cervical ribs clearly identify it as belonging to *Apatosaurus*. There can be little doubt that it is the cervical from lot I referred to in Cope's notebook as *Morosaurus laticollis*. Marsh had earlier in the year 1879 figured a similar cervical of *Apatosaurus laticollis*. (see Fig. 2).

As noted above, the two humeri H-1 and H-2, should be transferred from *Camarasaurus* to *Apatosaurus*. In addition, the bone Mtp 3, referred to by Osborn and Mook (1921) as metatarsal III of *Camarasaurus*, is probably metatarsal II of *Apatosaurus*. It is one of those bones marked AMNH 5761 without further identification, and is likely one of those from the later shipments ⟨15⟩ to ⟨17⟩.

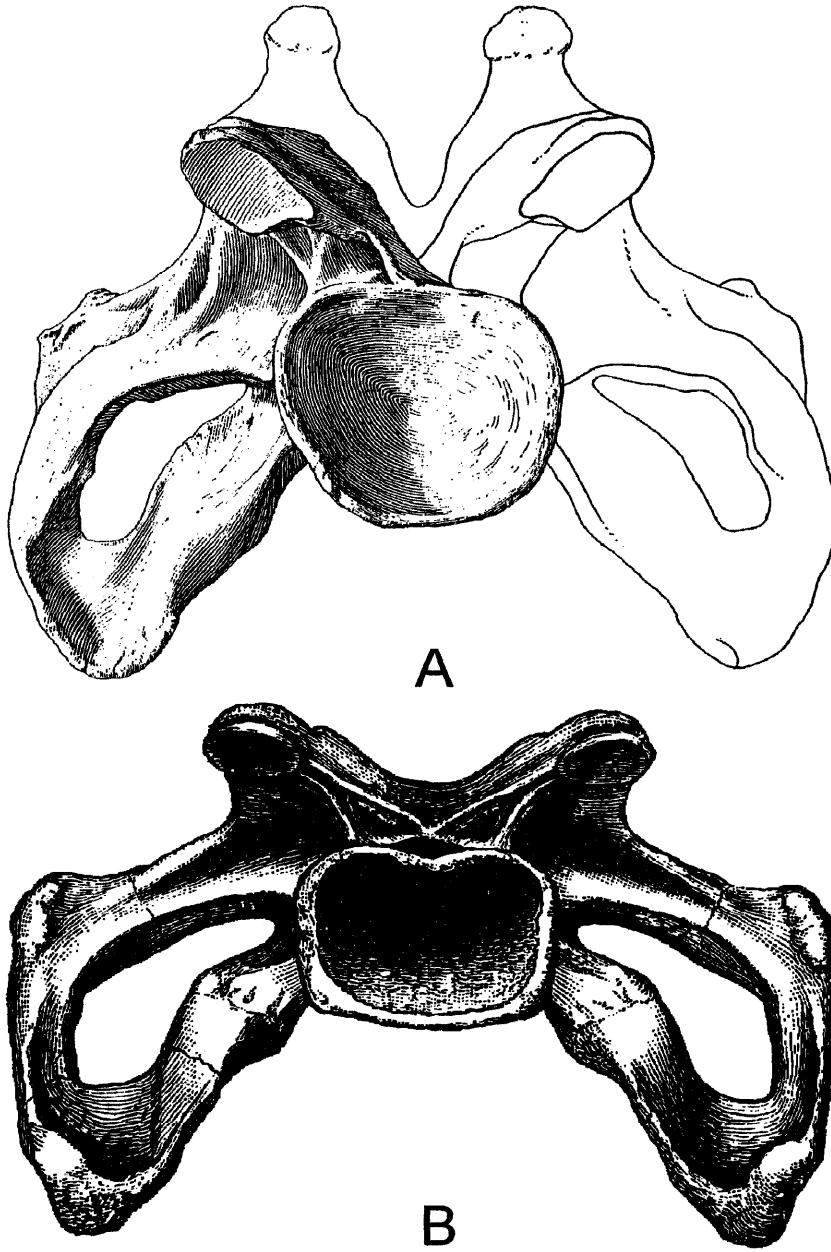

FIGURE 2 Posterior views of cervical vertebrae of *Apatosaurus* sp. (A) AMNH 5760/X-c-4 (from Osborn and Mook, 1921); (B) *Apatosaurus laticollis*, YPM 1861 (after Marsh, 1879).

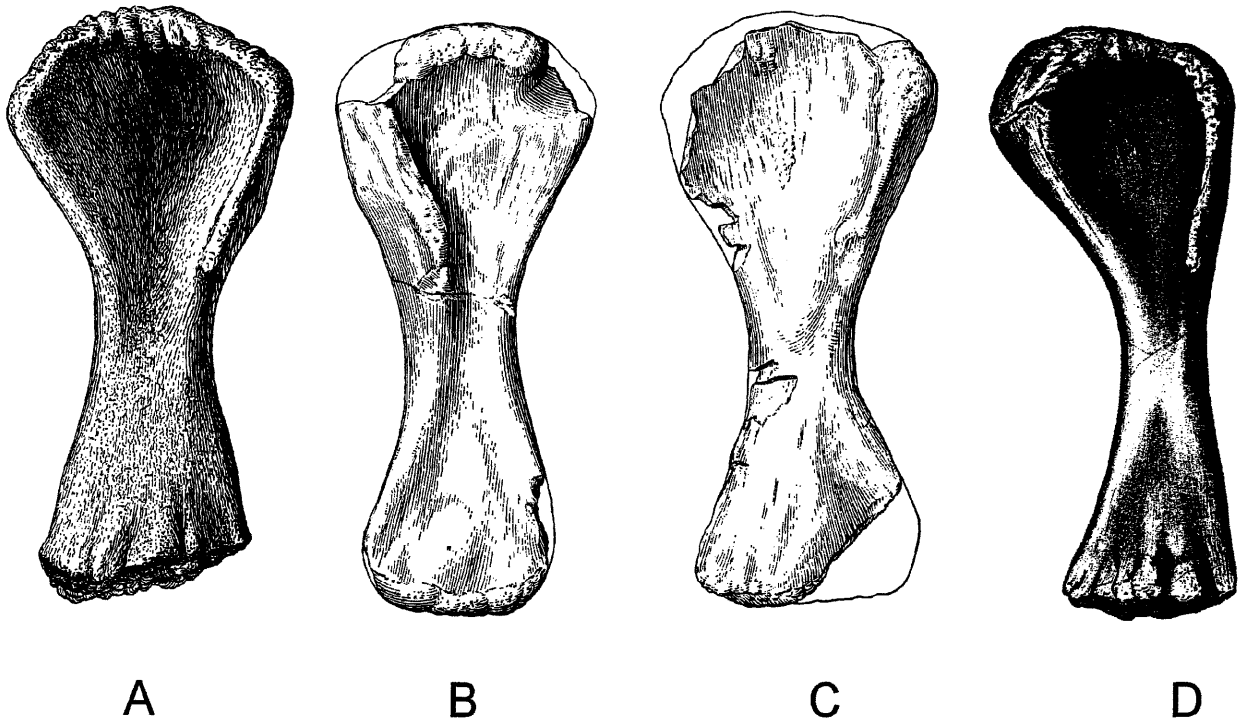

FIGURE 3 Anterior views of humeri of *Apatosaurus* and *Camarasaurus*. (A) *Apatosaurus louisae* (CM 3018, after Gilmore, 1936); (B), (C), *Camarasaurus supremus* (AMNH 5761/H-1 and 5761/H-2 after Osborn and Mook, 1921); (D) *Camarasaurus grandis* (YPM 1901, after Ostrom and McIntosh, 1966).

Amphicoelias fragillimus

The colossal dorsal vertebra (for which the catalogue number AMNH 5777 was reserved) from between lots I and II, upon which this species was founded is missing from the American Museum collections. A figure from Cope's original paper (Cope, 1878e) shows that it belonged to the largest diplodocid yet found. A perusal of the records of shipments ⟨8⟩ and ⟨10⟩ fails to reveal its presence in either. Thus, it is probable that the bone was sent some time in the summer of 1878 in a shipment of which records have been lost. Although loss of the fossil a major tragedy, there is no reason not to consider it a very large individual of *A. altus*.

Laelaps trihedrodon

Finally, although I do not intend to discuss in any detail the non-sauropod dinosaurs in the Cope Cañon City collection, a comment concerning the type specimen of *Laelaps trihedrodon* will be made. Osborn and Mook (1921, p. 258) state that the type is lost, but list a "second specimen of this animal, "AMNH 5780 *Laelaps trihedrodon* Number 2, 8 teeth". It is clear that Osborn and Mook have misinterpreted the "Number 2" of Cope's records. Rather than referring to a second individual of *Laelaps trihedrodon*, Number 2 is the "Fossil 2" of O.W. Lucas (see above) and the 8 teeth are what remain of the type specimen of that species. Cope's map indicates that it came from lot I.

Reconstruction of a Sauropod

One last correction to be made concerns Osborn and Mook's (1919, 1921) statement that Dr. John A. Ryder's full sized skeletal reconstruction of *Camarasaurus supremus* (Fig. 4) was first exhibited at the American Philosophical Society when Cope's major paper on the dinosaur was presented December 10, 1877. Mook (1914) published a much reduced version of this restoration for the first time and stated the drawing was constructed some time around 1878. It is clear that this date is the more nearly correct one. From Cope's paper (Cope, 1878a, p. 279) of the Proceedings there appears the following statement: "Prof. Cope displayed life size drawings of vertebrae, femoral and other bones of gigantic fossil saurians' of the genera *Lamarasaurus* (sic), and *Amphicoelias*..." No mention is made of the 68 foot long drawing. Ryder had no fore limb bones and at most one foot bone at the time the reconstruction was made. On the other hand, the first

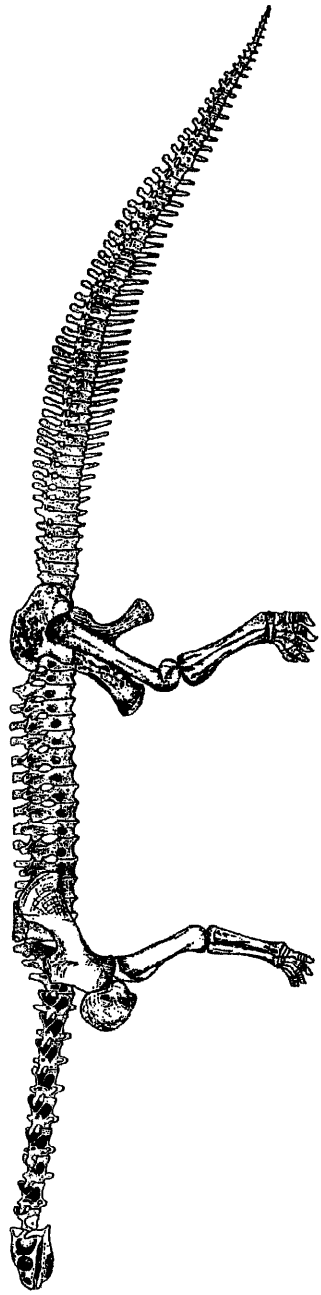

FIGURE 4 Dr. John Ryder's skeletal reconstruction of *Camarasaurus supremus* made under the direction of Prof. Cope (after Osborn and Mook, 1919, 1921).

FIGURE 5 Comparison of the limbs of illustrated by Marsh for *Camarasaurus grandis* with those by Ryder for *Camarasaurus supremus*. *C. grandis* forelimb (A), hindlimb (C), *C. supremus* forelimb (B), hindlimb (D).

reconstruction of the articulated limbs of a sauropod was that of *Morosaurus grandis* published by Marsh in November 1878 (Fig. 5). A comparison shows that there can be no question that Ryder used these figures as a guide in drawing the fore limb and both the fore and hind feet of his reconstruction. The reconstruction was probably drawn early in 1879 and remains the first skeletal reconstruction of a sauropod. The first *published* skeletal reconstruction of a sauropod was that of *Brontosaurus* presented by Marsh four years later (Marsh, 1883).

CONCLUSIONS

This paper is a preliminary report of newly found records of the Cope sauropod collection. It identifies for the first time the precise localities of a number of type specimens. In particular, the location of the site of the type skeleton of *Amphicoelias altus* may lead to the collection of more material of this little understood sauropod. The possibility of separating the different individuals of *Camarasaurus supremus* AMNH 5761 may soon be possible. Finally some erroneous assertions in Osborn and Mook's (1921) great monograph are corrected, perhaps the most important of which is the removal of humeri H-1 and H-2 from *Camarasaurus* to *Apatosaurus*.

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