NOTES ON THE POSTCRANIUM OF *CAMPTOSAURUS*

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INTRODUCTION

Remains of the ornithopod *Camptosaurus* are relatively scarce compared to those of most other dinosaurs from the Morrison despite its occurrence throughout this late Jurassic formation. Dodson et. al. (1980) suggest that it may have been somewhat segregated ecologically. Skeletal disarticulation and mixing is also the normal condition of bones within these deposits (Dodson et. al., 1980; Dodson and Madsen, 1981). Both of these factors likely contribute to the relative scarcity of *Camptosaurus* materials. Articulated and associated remains of individual animals therefore hold special interest as potential sources of new information about this interesting reptile.

By comparison with other specimens a new, partly complete postcranial skeleton of *Camptosaurus* from the Morrison Formation of Wyoming is remarkable because of its large size and extensive coosifications in some regions of the skeleton. These features are interpreted as an expression of an advanced stage of bone development as a concomitant of the individual's age. Previously described materials of *Camptosaurus* offer little basis for conclusions about size versus chronologic age of an individual. For discussion of size and proportions see Dodson, 1980.

The new skeleton is also of note because it possesses a shoulder girdle with associated, paired sternals, a distinctive pelvic girdle, and numerous elements belonging to the forelimbs and feet including the first digit with an unusual ungual "spike".

DESCRIPTION
Order ORNITHISCIA
Sub Order ORNITHOPODA
Family IGUANODONTIDAE
Camptosaurus Marsh, 1885

Referred specimen—SMM P84.15.5, incomplete skeleton from the Morrison Formation, Late Jurassic, Sec 36, T. 48 N, R. 83 W, Johnson Co., Wyoming (Poison Creek Quarry).

Only the pelvis and a section of the posterior dorsal vertebral series were articulated when discovered. Other elements consisting of fragmented cervical vertebrae, a series of anterior dorsal vertebrae, pectoral girdle, forelimbs and feet were semi-articulated or associated.

The vertebral column is represented by five partial cervical centra, most lacking their neural arches and a dorsal series of 14 elements. Following Gilmore's count, numbers 1-10 and 12-15 are represented. If 16 dorsals were present (Galton, 1980; Dodson, 1980) an additional element after number 10 is lacking. Most have their neural arches intact. A nearly complete sacrum with a sacro-dorsal, sacro-caudal and five sacrals and three proximal caudals account for the remainder of the column (Table 1). All of the dorsals have their neural arches coosified with their respective centra and lack pronounced suturing. The caudals have pronounced neuro-central sutures. They are robust and exhibit pronounced irregular expansion of their extremities. Dorsal 10 is pathomorphic showing severe compression fracturing of the centrum and callous development as a result of healing. The injury to the back was probably more extensive than indicated and likely would have been reflected in missing vertebrae.

Six vertebrae are thoroughly fused into a sacral complex (Fig. 1,A). In contrast to the sacra of other *Camptosaurus*, bone fusion at intervertebral areas has progressed to the point of obliterating all indication of distinct vertebral contacts. As far as they are preserved the neural arches show a similar fusion with their centra. If, as in *C. browni* USNM 4282 (Gilmore, 1909), only those elements which support true sacral ribs are to be regarded as true sacrals, the present individual also has five sacrals; however, the posterior

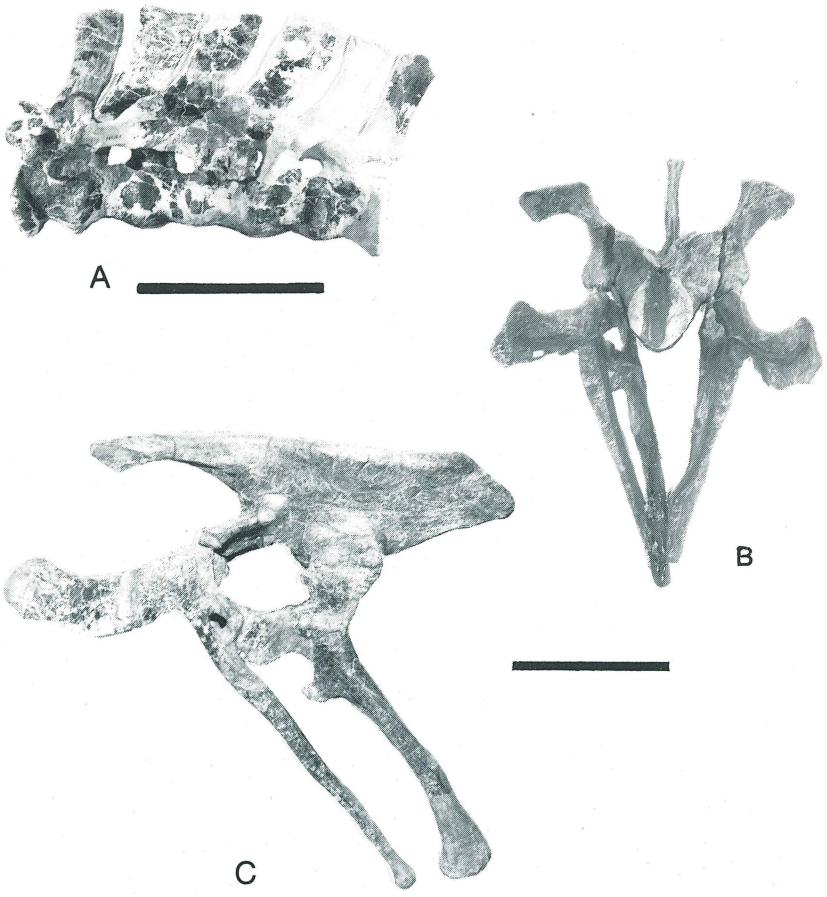


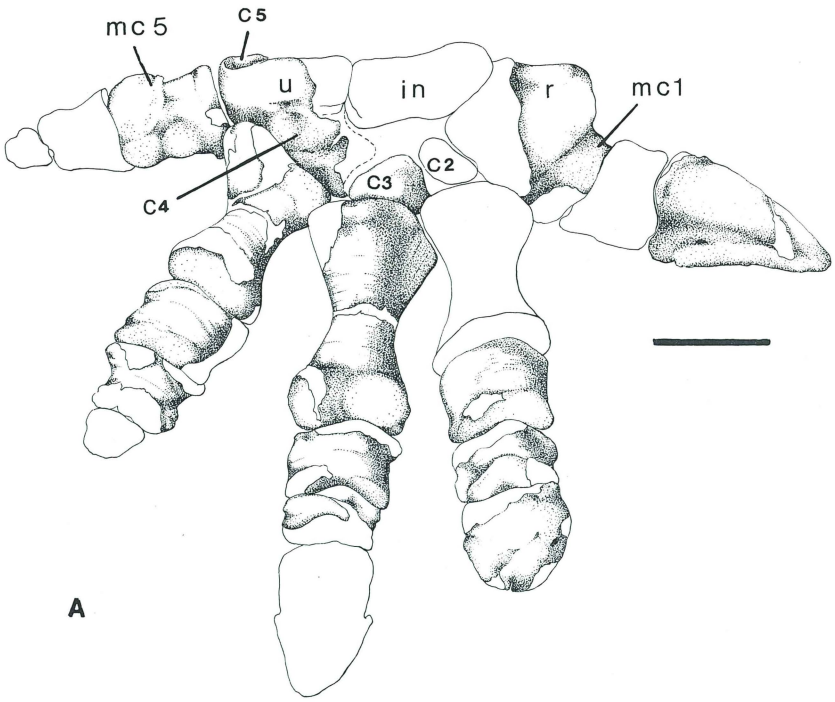
Figure 1. Pelvis of *Camptosaurus* P84.15.5. A, sacrum with fused sacro-dorsal at left; B, anterior view of fully articulated pelvis showing sacro-dorsal and diapophyses of first sacral contacting ilia; C, articulated ilium, pubis and ischium in left lateral view. Scale bars equal 30 cm.

contact surfaces of the ilia as well as the vertebral contact surfaces of the fifth sacral vertebra are not preserved. These vertebrae are totally coosified with one another. The first vertebra in the series of six therefore represents the sacro-dorsal. However, unlike this element in USNM 4282, it is completely fused to the centrum of the first sacral. Figure 1,B provides, in anterior view, the ilia contacts with the massive diapophyses of the first sacral. As the last vertebra in the series has lost its entire posterior face there is no way to demonstrate its union with the last sacral. Incipient fusion seen in other individuals appears to be an expression of growth stages in individuals relatively younger than the present specimen.

The pectoral girdle is mentioned for the record because paired scapulae, coracoids and sternal plates are preserved. Their chief distinction is size (Fig. 3, A and B and Table 2). For discussion of sternals see Dodson and Madsen, 1981.

Gilmore (1909) considers the ilium one of the most characteristic bones among species and illustrates its various forms with emphasis on contours and proportions. By comparison, SMM P84.15.5 is characteristically camptosaurid and has closest agreement with *C. dispar.* It is much more robust with a greatly expanded superior blade and peduncle. The ischium and post-pubis are relatively short in comparison, however neither is totally intact distally and therefore have been restored with some reservations. The anterior pubis is complete and also short however, suggesting that these other elements may have been short as well. Distortion prevents proper alignment of the post-pubis and ischium but otherwise there is little deformation of the pelvis. With all pelvic bones in near normal association (Fig. 1,C) the pelvis reveals a massiveness and proportions unrivaled by other *Camptosaurus* (Table 3).

Figure 2. Forefoot of *Camptosaurus* P84.15.5. A, dorsal view of right manus; c, carpal; in, intermedium; mc, metacarpal; r, radiale; u, ulnare. B-E, first phalange and ungual of Digit I of left manus in dorsal, medial, ventral and lateral views respectively. Scale bars equal 5 cm.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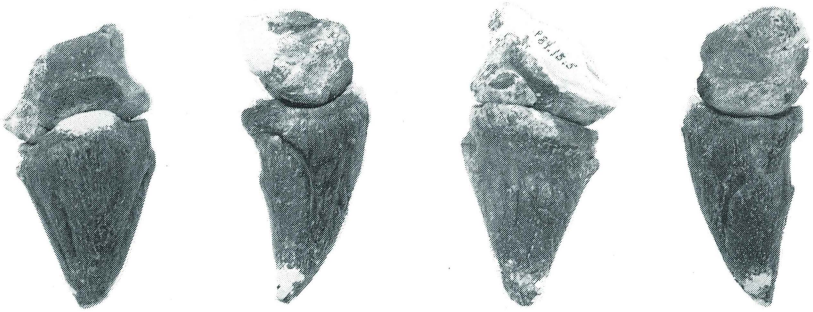
B
C
D
E

Both forelimbs are present and mostly intact. These elements are remarkable for their size (Table 2). The humerus (Fig. 3 and Table 2) is 468 mm long making it 1.30 x larger than that of USNM 4282 (Gilmore, 1909) which is the longest (360 mm) known *Camptosaurus* humerus. Assuming a similar body length/humerus ratio, P85.15.5 had a body length of 6.73 meters compared to a body length of 5.18 meters for USNM 4282. The live weight of USNM 4282 is estimated to have been 1,000 Kg. (D. A. Russell, pers. comm., 1985). Body weight for the new specimen is calculated (1,000 x 1.30^3) at 2,197 Kg. This is still considerably less than Russell's estimate of 3,856 Kg. for *C. amplus* (pers. comm., 1985). Of the forefeet the right carpus is most complete and is shown with the entire right forefoot in Figure 2,A. Missing elements have been restored after Gilmore. It possesses the following features: the first carpal has totally merged with the radial and metacarpal I on the palmar surface; carpal two is missing; number three has been inserted in the foot as a free element as its contacts with the radial and intermedium are not preserved; the fourth as well as the fifth carpal is solidly fused to the ulnare. Their definition as discrete bones is nearly obliterated.

Fusion of metacarpal I and the radiale is complete with little indication of distinction between the two. The ungual phalange of this digit is a spike-like structure (Fig. 2, B-E), sub-circular at its proximal end and bluntly pointed at the other. As noted by Sereno (1986) it is one of several unique specializations of digit 1 of *Camptosaurus*. Its length is 8.5 cm and its surface is impressed with deep vascular channels. The sheath that enclosed it in life was evidently a long, formidable, only slightly-curved claw. This structure is being currently studied by Sereno and its significance will be discussed in his forthcoming paper on ornithopod phylogeny.

The other unguals are missing from both feet with the exception of the other "spike" (Fig. 2, B-E) from the first digit of the left forefoot and the ungual of the second digit of the right forefoot. This element is dorsoventrally compressed and also possesses a stout but short and blunt extremity (Fig. 2,A).

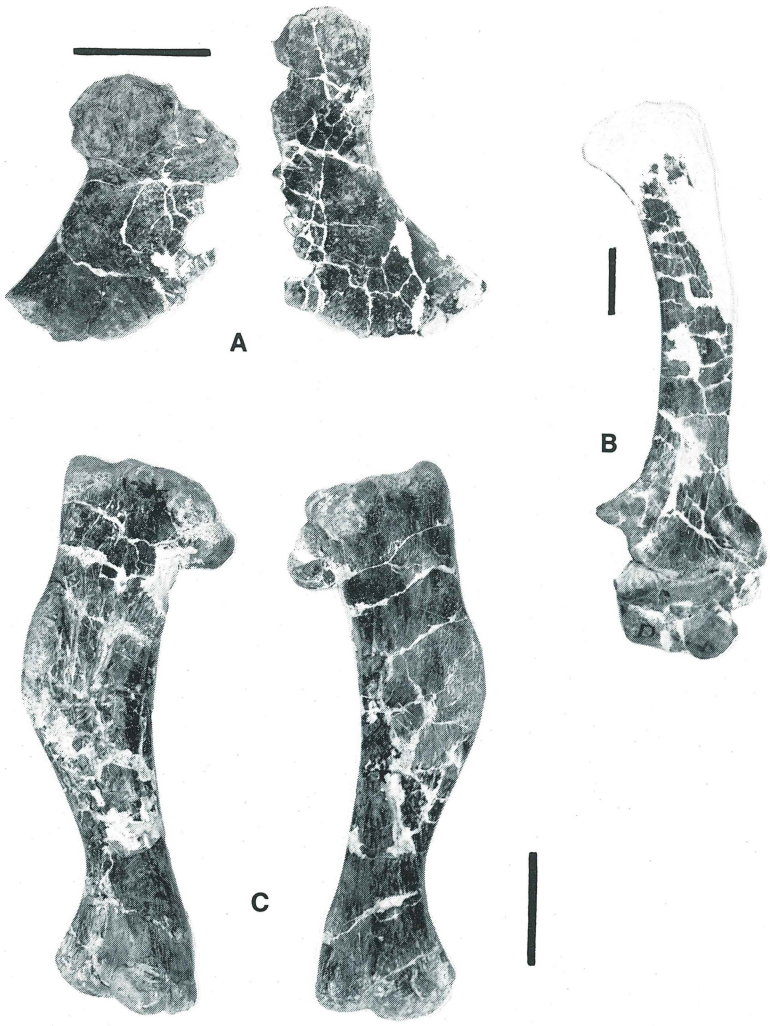

Figure 3. Shoulder girdle and humerus of *Camptosaurus* P84.15.5. A, sternal plates in ventral view, anterior end up; B, right scapula and coracoid in lateral view; C, right humerus in anterior view (left) and posterior view (right). Scale bars equal 10 cm.

CONCLUSIONS

Generally regarded as a moderate-sized dinosaur, *Camptosaurus* has provided a few skeletons among numerous fragmentary specimens which perpetuate this notion. Exceptions are *C. amplus* (Marsh, 1879) which represents a fairly large animal, and the partly complete skeleton SMM P84.15.5. Based on previous materials Dodson (1980) calculated a maximum body length of nearly six meters for *Camptosaurus*. An exceptional skeleton, SMM P84.15.5 provides further measure of body length, derived from presacral and sacral regions, that suggests a total body length approaching seven meters. *C. amplus* was evidently longer yet with an estimated length of 8.13 meters (Russell, pers. comm., 1985). Smaller skeletons probably belong to younger individuals or may represent smaller species. The picture is incomplete. Progressive fusion of certain areas viz; sacrum and manus of the skeleton, seems to be a normal condition of aging in *Camptosaurus*, and in this individual, with little or no osteoporosis (bone deterioration).

Coosification within the manus is a shared feature which unites *Camptosaurus* with *Iguanodon* and *Ouranosaurus* (Dodson, 1980; Sereno, 1986). The manus of the present skeleton shows a maximum degree of fusion wherein recognition of certain elements can be made only by previous knowledge of their presence. Fusion of the first metacarpal with the radiale and carpals 4 and 5 with the ulnare becomes complete with age. Joining of the radiale or ulnare with the intermedium is a character that apparently also has a progressive aspect throughout life. The ungual of the first digit however retained a functional mobility throughout life for whatever use it may have had.

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Table 1. Maximum measurements of vertebral centra of *Camptosaurus* P84.15.5 in cm.

Dorsal vertebra breadth	length	mid height	anterior breadth	posterior breadth
1	9.0	5.7	6.5	6.5 est
2	9.3	6.1	6.7	6.8 est
3	8.9	5.4	7.2	7.2 est
4	9.3	6.6	6.2	6.0
5	9.9	5.6	7.2	7.0
6	9.8	6.2	8.1	7.3
7	9.2	6.6	8.4	8.0
8	8.8	7.0	8.0	8.3
9	9.1	7.8	8.3	8.6 est
10	9.2 est	8.1 est	9.6	11.0
12	9.4	8.5	8.6	9.7
13	9.2	9.0 est	10.2	1.3 est
14	9.6	9.9	10.1 est	10.2 est
15	10.3 est	10.2 est	10.2 est	11.4
Caudal vertebra				
2	9.3	12.0	10.2 est	10.2
3	9.3	11.2	9.9 est	9.1 est
4	9.2	11.5	10.3	10.4

Table 2. Maximum measurements of the shoulder girdle and forelimb of *Camptosaurus* P84.15.5 in cm.

Element	length	mid breath	proximal width	distal width
Scapula	68.0 est		17.2 est	25.5
Coracoid	14.3		22.5 est	
Sternal plate	24.9	11.5		
		mid-shaft circumference		
Humerus	46.8	20.1	16.5	13.0
Radius	29.7	10.5	6.9	6.6
Ulna	31.0 est	12.5	10.8	5.5 est

Table 3. Maximum measurements of pelvic girdle of *Camptosaurus* P84.15.5 in cm.

Ilium

length 80.5

height 25.0

length of anterior process 29.0

Pubis

length of anterior process (lateral surface) 40.5

length of posterior process ..... 72.0 (est.)

Ischium

length ..... 71.5 (est.)

Diameter of acetabular opening (lateral surface) 17.5

REFERENCES

Dodson, P., 1980. Comparative osteology of the American ornithopods *Camptosaurus* and *Tenontosaurus*. *Mem. Soc. Geol. Fr., N. S., 139*: 81-85.

Dodson, P., A. K. Behrensmeyer, and R. T. Bakker, 1980. Taphonomy and paleoecology of the dinosaur beds of the Jurassic Morrison Formation. *Paleobiology, 6 (2)*: 208-232.

Dodson , P. & J. H. Madsen, Jr., 1981. On the Sternum of *Camptosaurus*. *Journal of Paleontology*, 55 (1): 109-112.

Galton, P. M., 1980. *Dryosaurus* and *Camptosaurus*, intercontinental genera of Upper Jurassic ornithopod dinosaurs. *Mem. Soc. Geol. Fr., N. S., 139*: 103-108.

Gilmore, C.W. 1909. Osteology of the Jurassic Reptile *Camptosaurus*, with a revision of the species of the genus, and descriptions of two new species. *Proceedings U.S. National Museum, Vol. 36 - No. 1666*: 197-332.

Marsh, O.C. 1879. Notice of new Jurassic reptiles, *Amer. Jour. Sci., Sec. 3, Vol. 18*: 501-505.

Sereno, P.C. 1986. Phylogeny of the Bird-hipped Dinosaurus (Order Ornithischia). *National Geographic Research* 2(2): 234-256.