

**Article XXXI.—THE FORE AND HIND LIMBS OF *DIPLODOCUS*.**

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Although a considerable amount of material belonging to the sauropod dinosaur *Diplodocus* has been described, none of these descriptions has included a discussion of fore and hind limbs belonging to one individual. The material herein described was found by Mr. Barnum Brown of the American Museum of Natural History, in the Field Expedition of 1903, at Horse Coulé, 30 miles east of Pryor, Montana. The field relations of the bones, according to Mr. Brown, indicated clearly that they belonged to one individual. This material consists of a partially complete right scapula, and a nearly perfect left scapula and coracoid, right and left humeri, right and left radii and ulnæ, the distal half of the right femur and complete left femur, right and left tibiæ, fibulæ, and astragali, and a fragmentary pelvic bone. The bones together constitute No. 5855 of the American Museum Collection of Fossil Reptiles. These remains were studied by the writer for Professor Henry Fairfield Osborn in connection with the work on the monograph on the Sauropoda now in course of preparation for the United States Geological Survey.

The material under discussion was first identified as *Morosaurus*, but it now appears that this identification was incorrect and that the bones belong to *Diplodocus*. The reasons for the latter identification are as follows: 1st, the bones are practically all slender. In *Camarasaurus* (*Morosaurus*) the limbs, especially the hind limbs, are massive in form; 2d, the longitudinal axis of the scapula and the axis of greatest breadth make a very oblique angle with each other. This is also true of several scapulæ which are associated with undoubted *Diplodocus* vertebræ (Amer. Mus. No. 221, Carn. Mus. No. 94). The scapula of *Camarasaurus* (*Morosaurus*) has these two axes almost perpendicular with each other. 3d, the scapula is only moderately expanded at both superior and inferior ends; 4th, the ulna is not twisted in the manner characteristic of *Camarasaurus* (*Morosaurus*). The foregoing characters indicate *Diplodocus* as the correct identification for the material under consideration.

This material is of especial interest because it affords opportunity for the use of ratios between the various components of the fore and hind limbs. The scapula and coracoid are fused with each other, though the fusion is not complete in the region of the glenoid; the superior border is not complete in either specimen, but was evidently only slightly expanded. The shaft is short on its anterior border and of moderate length on its posterior side.

The inferior expansion is not very pronounced in either direction; in the posterior direction it is especially short. The anterior part of the inferior expansion extends for a considerable distance in a superior direction. This makes the axis of greatest breadth (from the posterior border of the glenoid to the superior point of the antero-inferior expansion) form a very oblique angle with the longitudinal axis. The glenoid surface of the scapula is short. The coracoid is subcircular rather than subquadrilateral. Its fore-and-aft diameter is greater than its vertical height. The coracoid foramen is situated very close to the coraco-scapular border.

*Measurements, left scapula and coracoid.*

1. Total length of scapula and coracoid (not quite complete) . . . . .	92.5 cm.
2. Breadth across oblique axis . . . . .	44.0
3. Antero-posterior diameter of coracoid . . . . .	26.0
4. Vertical diameter of coracoid, estimated . . . . .	21.0
5. Length of glenoid surface . . . . .	20.0
6. Breadth of shaft . . . . .	14.0
7. Breadth of superior end (incomplete) . . . . .	23.5

The humerus is very short in proportion to the length of the scapula and of the femur. It is comparatively slender and has a prominent deltoid

crest. The crest extends inward, over the antero-superior fossa to a considerable extent, giving the humerus a twisted appearance. In the left specimen this effect has been increased by crushing. There is a prominent, though small, process on the center of the superior border; this process evidently articulated with the glenoid, and it indicates that the humerus was usually held in a highly inclined position. The shaft is comparatively long and slender. The distal end is expanded, the axis of expansion being somewhat oblique to the broad axis of the superior end. On the center of the antero-inferior border is a pair of small processes which assisted in

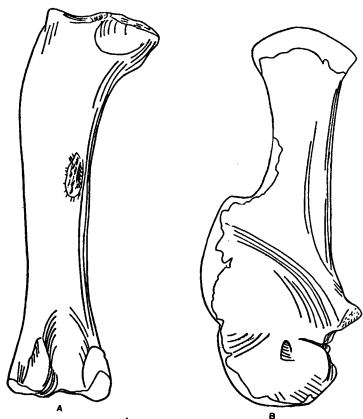


Fig. 1. Scapula, coracoid, and femur of *Dipodocus* (Amer. Mus. No. 5855), one-twentieth natural size. A, left femur, posterior view. B, left scapula and coracoid, external view.

supporting the radius and ulna when the humerus was greatly inclined. The prominence of these processes favors the idea of the humerus being customarily placed in an oblique position. The distal end is thick.

*Measurements of left humerus.*

1. Length, total.....	75.0 cm.
2. Breadth, proximal end; estimated.....	28.5
3. Breadth, distal end.....	21.5
4. Distance from middle of proximal border to distal end of deltoid crest.....	35.0
5. Distance from distal end of deltoid crest to center of distal border of humerus.....	41.0
6. Ratio of 5 to 4.....	.853
7. Circumference.....	32.0
8. Index.....	.426

The radius and ulna are very small in comparison to the size of the humerus. The ulna has a shallow excavation on the superior portion of the anterior surface, which lodged the proximal end of the radius. The proximal end of the ulna is triangular in outline. The largest surface is the internal one, which is concave. The external one is flat. All three surfaces decrease in size toward the distal end, and their intersections become more or less obliterated, the outline of the distal end being subovate. On the antero-internal border is a slight depression which lodged the distal end of the radius. The radius is slightly flattened at the proximal end, the greatest diameter being the right and left. The shaft is slender, is broader than deep, and is slightly curved. The distal end is expanded and subcircular in outline.

*Measurements, index, and ratios, left ulna.*

1. Length, total.....	54.5 cm.
2. Greatest diameter, proximal end.....	14.5
3. Greatest diameter, distal end.....	10.0
4. Circumference.....	19.5
5. Index.....	.357
6. Ratio of length of humerus to length of ulna.....	.726
7. Ratio of length of tibia to length of ulna.....	.949

*Measurements, index, and ratios, left radius.*

1. Length, total.....	52.5 cm.
2. Greatest diameter, proximal end.....	10.5
3. Greatest diameter, distal end.....	11.5
4. Circumference.....	19.5
5. Index.....	.371
6. Ratio of length of humerus to length of radius.....	.700
7. Ratio of length of fibula to length of radius.....	.660

The femur is long and slender. The head is comparatively small, and is pointed. The great trochanter is set off rather sharply from the main body of the femur. The fourth trochanter is comparatively near the proximal

end. The shaft, below the fourth trochanter, is slender. Both fibular and tibial condyles are large, especially the latter. The intercondylar groove is deep. A corresponding groove on the anterior surface of the distal portion of the femur is also deep. This groove evidently lodged a large tendon or muscle.

*Measurements, index, and ratios of left femur.*

1. Length, total.....	113.5 cm.
2. Breadth, proximal end.....	31.5
3. Breadth, distal end.....	28.5
4. Length from center of proximal border to center of fourth trochanter.....	50.0
5. Length from center of fourth trochanter to center of distal border..	60.5
6. Ratio of 5 to 4.....	.826
7. Circumference.....	40.5
8. Index.....	.356
9. Ratio of length of femur to length of humerus.....	.660
10. Ratio of length of femur to length of tibia.....	.696
11. Ratio of length of femur to length of fibula.....	.700

The tibia is much smaller than the femur. It is slender. The proximal

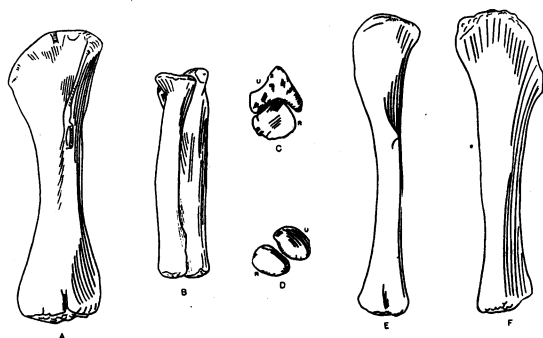


Fig. 2. Limb bones of *Diplodocus* (Amer. Mus. No. 5855), one-twentieth natural size. A, left humerus, anterior view. B, left radius and ulna, anterior view. C, left radius and ulna, proximal view. D, left radius and ulna, distal view. E, left fibula, external view. F, left tibia, anterior view. R, radius; U, ulna.

end is round and not flat as many sauropod tibiae are known to be. This may be largely due to absence of crushing. The fibular ridge on the supero-external surface is small. The shaft is slender. The distal end has a cavity which lodged the ascending process of the astragalus. The internal border extends slightly below the external border. The distal end is expanded, the expansion assisting in locking the distal end of the fibula in place.

The fibula is long and slender. It is quite deep antero-posteriorly at

the proximal end and narrows gradually to a point near the distal end, from which it rapidly expands again. Laterally the fibula is exceedingly slender. There is a prominent rugosity, which formed the attachment for a prominent muscle, somewhat above the middle of the shaft on the external surface. This rugosity is situated on a ridge which merges distally into the posterior surface of the bone.

*Measurements, index, and ratios of left tibia.*

1. Length, total . . . . .	79.0 cm.
2. Greatest diameter, proximal end, including fibular ridge . . . . .	24.5
3. Greatest diameter, distal end . . . . .	18.0
4. Circumference . . . . .	27.5
5. Index . . . . .	348
6. Ratios (see measurements of ulna and femur).	

*Measurements, index, and ratios of left fibula.*

1. Length, total . . . . .	79.5 cm.
2. Greatest diameter, proximal end . . . . .	18.0
3. Greatest diameter, distal end . . . . .	13.0
4. Distance from center of proximal border to center of external rugosity . . . . .	33.5
5. Distance from center of external rugosity to center of distal border . . . . .	45.5
6. Ratio of 5 to 4 . . . . .	.736
7. Thickness of shaft, laterally, a short distance above distal end . . . . .	3.3
8. Ratios (see measurements of radius and femur).	
9. Circumference . . . . .	17.5
10. Index . . . . .	220

The interest in this material lies, of course, in the reliable manner in which the relative proportions of the various elements of the fore and hind limbs may be ascertained. The humerus is slightly less than two-thirds as long as the femur, while the tibia and fibula are about seven tenths as long as the femur. These proportions may be of use in determining the size of individuals of *Diplodocus* from incomplete skeletons.

The accompanying outlines indicate the above-mentioned proportions graphically. The material will be fully illustrated in the Sauropoda Monograph.

