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A SKELETON OF ASTRAPOTHERIUM[1]

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Fossil mammals of the order Astrapotheria have been known from South America since 1853. Four genera of astrapotheres proper have been described and generally recognized. These forms, in some instances, are based upon series of teeth and fragments of jaws, but the genus *Astrapotherium* has long been known from splendid skulls with associated mandibles.

Until the discovery of the specimen under discussion the structure of skeleton in all members of the order remained unknown save a single forefoot of *Parastrapotherium* (Princeton University Expeditions to Patagonia, **6**, pl. XXXVI) and the scapula and bones of the foreleg (Annales de Paleontologie, **1**, p. 19), with an isolated astragalus. The femur figured by Gaudry (*ibid.*, p. 4, fig. 5) is clearly that of *Homalodotherium;* the tibia figured with it is so unlike those of the specimen in hand as to render it highly improbable that it could have belonged to a member of the genus *Astrapotherium.*

Field Museum was so fortunate as to secure from the Santa Cruz beds of middle Miocene age a skeleton of *Astrapotherium magnum* (P14251) sufficiently complete to make possible a study of the entire osteology of the animal. This skeleton is almost entire and can be mounted as an articulated specimen, as may be seen in figure 39. However, much of the vertebral column, ribs, and pelvis has been so dissolved by percolating waters that only shells of the bones remained. For this reason the vertebrae and ribs could not be removed from the matrix, nor could the specimen be set up as a free mount. The posture of an animal lying down has been chosen for it and the position of the head and legs has been made to conform to this posture as nearly as was possible. The deformation of parts, due to compression in the matrix, could not be corrected. The preparation was carried out by the late J. B. Abbott under

[1] Read before the Paleontological Society, December 28, 1934. Abstract, Proc. G. S. A., 1934, p. 379.

the writer's supervision. Specimens of *Astrapothericulus* (?)[1] and of *Parastrapotherium* were used as guides in restoring missing parts.

The mounted specimen shows that *Astrapotherium magnum* was a long-bodied animal, having a moderately long neck, a deep thorax, relatively long and strong forelegs, weaker hind quarters and slender hind legs. The skeleton as mounted is 9 feet 5 inches (2.88 meters) in length from the nose to the extremity of the pelvis and would stand about 4 feet 6 inches (1.37 meters) in height at the shoulders.

The *skull* is that of a large adult animal, judging from comparison with other specimens in this Museum as well as with figured specimens from other collections. The animal has a large head, short nasal bones, and widely open nasal passages which have been interpreted as indicating the presence in life of a moderately developed proboscis. There are no upper incisors; the canine teeth both above and below are angular and grow throughout the life of the individual. The premolars are reduced in size and in numbers; the molars are massive and of a lophodont pattern not unlike those of the Oligocene aquatic rhinoceros, *Metamynodon*. Skulls of this species have been figured in a number of publications and are too well known to require detailed description here.

Vertebrae.—The *atlas* has moderately broad and backwardly directed transverse processes. The axis is relatively strong and has an elongate centrum and a broad spine, which is thickened and vertical at the posterior margin. The odontoid process is elongate and rounded, and, like that of the amblypods, extends quite through the arch of the atlas. The anterior articular surfaces are subtriangular in outline and are strongly oblique to the axial direction. The succeeding cervicals are of moderate length and have strong articulations, as is common to heavy-headed animals. The transverse processes in the posterior five cervicals are expanded into broad lateral plates; the neural spines, though broken in this specimen, were evidently short.

The *dorsal vertebrae* are relatively slight and are little differentiated throughout the series. The spines in the anterior members of the series are short and tapering; in the posterior members they change to a short, broad type. The zygapophyses are rather widely spaced throughout the series, but in the thirteenth and fourteenth there is a transition from the upward-and-downward-facing type to the lateral-facing one common to ungulates. From that point to the

[1] The identification of this specimen is in doubt as there is no skull associated with it.

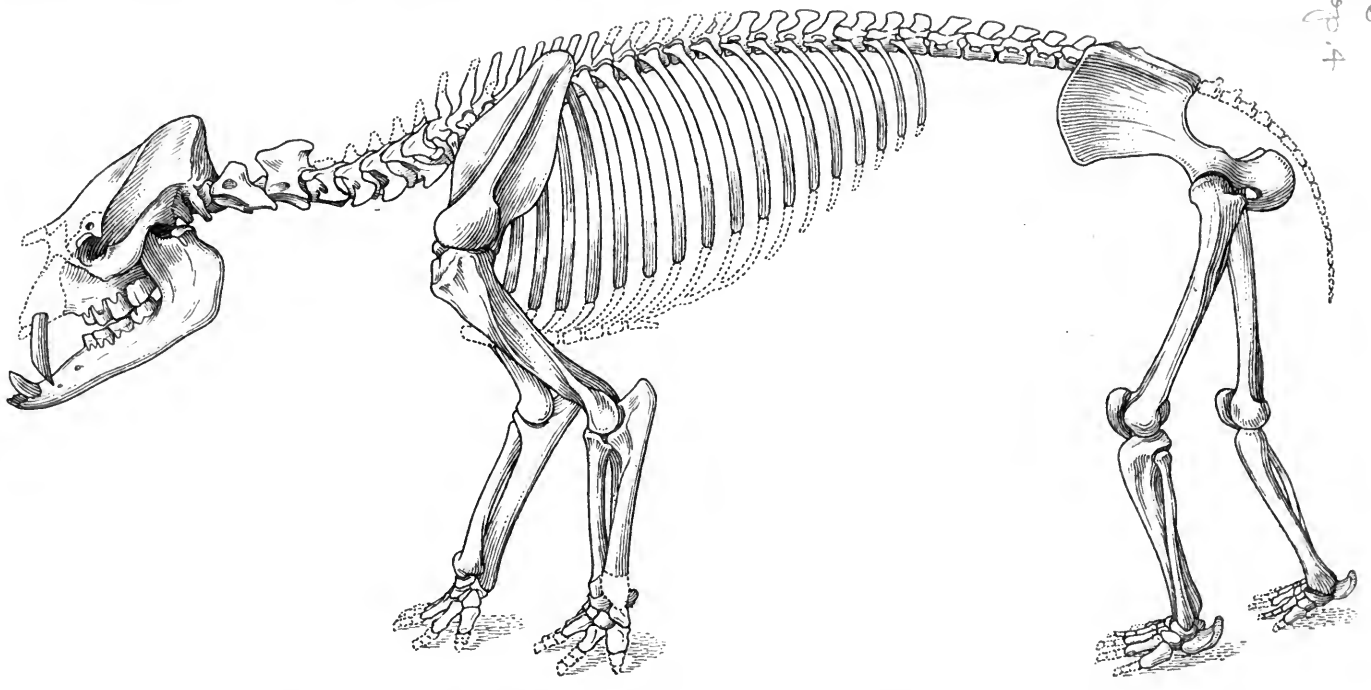

FIG. 36. Restoration of *Astrapotherium magnum*. From F.M. No. P14251, x 1/16. Restored parts indicated by dotted lines.

sacrum the zygapophyses are interlocking. The *lumbar vertebrae* are surprisingly weak for so large an animal. Their spines are low and broad; the crests, as seen from above, are bifurcate posteriorly. The transverse processes are short and laterally directed. The *sacrum* consists of five vertebrae which are firmly co-ossified but apparently have separate spines. There is no confirmation of this observation in other related specimens. The spines are broken close to the arch and lost; the same is true of the specimen of *Astrapothericulus* (?). The lateral processes are rather broad and join the ilia at their superior margins.

The convex outline of the vertebral column in the dorsal region is largely due to the position the specimen had taken in the matrix and does not represent the natural outline of the back of the animal in a recumbent position. However, the back of the animal in a standing position would probably have been convex from the shoulders to the mid-dorsal region and straight from that point through the lumbar region, as is indicated in the restoration (fig. 36). There are nineteen dorsal vertebrae and five lumbars, making a total of twenty-four dorso-lumbar vertebrae in the series.

The *scapulae* are elongate and tapering at the upper end, similar in a general way to that of *Homalodotherium* so far as may be seen from the Field Museum specimen (P13092) though less rounded in outline than restored by Scott (Field Mus. Nat. Hist., Geol. Mem., I, No. 1, pl. 7). The spine is simple, broad at the crest, and expanded at the lower end into a broad acromion process. It divides the lateral surface of the scapula into two approximately equal areas. The deep fossae thus formed indicate a considerable strength and great freedom of movement in the scapular muscles.

The *pelvis* is relatively weaker than the shoulder-girdle, much weaker than the same element in the specimen of *Astrapothericulus* (?). It is more elongate antero-posteriorly than that of known toxodonts and litopterns. More than two-thirds of its entire length lies in front of the acetabulum. The anterior extremities of the ilia are somewhat broken but appear to have been rounded with a rather sharp antero-inferior angle; the mesial surfaces have contact with the sacrum throughout their entire length.

The *humerus* is a relatively strong bone and almost as long as the femur. It has a prominent tuberosity, an elongate but strongly marked deltoid area which terminates at a point below the middle of the shaft, a wide but simple bicipital groove, and a moderately developed supinator ridge. The proximal articular surface extends

well around to the posterior side of the shaft, indicating a considerable angulation in the shoulder joint.

The *ulna* and *radius* are of similar size and strength in the shaft. The ulna, in its total length, is somewhat shorter than the humerus. The olecranon is in continuous line with the shaft; the sigmoid notch is wide and deeply cleft at its anterior margin to receive the head of the radius as figured by Gaudry (Annales de Paleontologie, **1,**

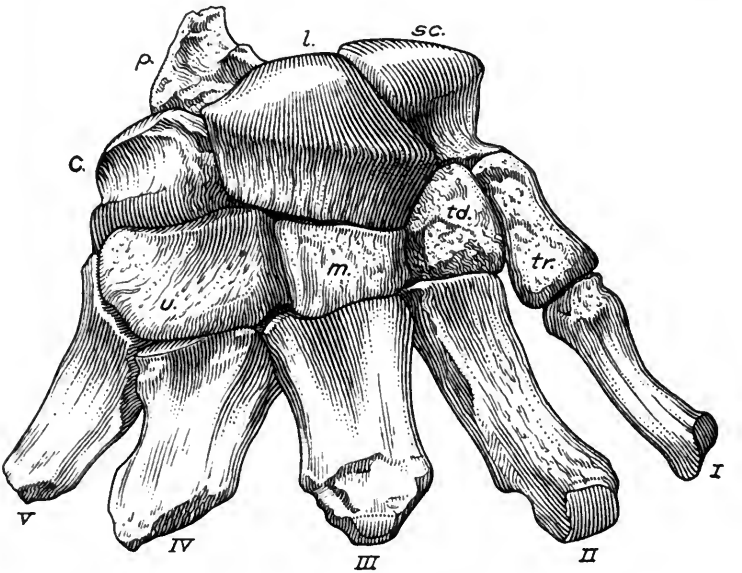

FIG. 37. Right manus of *Astrapotherium magnum*. F.M. No. P14251, x 1/3. *sc.*, scaphoid; *l.*, lunar; *c.*, cuneiform; *p.*, pisiform; *u.*, unciform; *m.*, magnum; *td.*, trapezoid; *tr.*, trapezium; I–V, metacarpals.

p. 5, fig. 5). The distal articulation of this bone has the form of a facet placed obliquely to the shaft and extending well over the distal end. It has the unusual feature of articulating with the lunar as well as the unciform and the pisiform bones. The radius is moderately curved in the shaft and but little larger at the distal, than at the proximal end. The proximal articulation is concavo-convex in form and elongate in the transverse direction, covering the entire breadth of the trochlea. The anterior margin of the radial facet is straight; the posterior margin is angular and, fitting closely the notched articulation in the ulna, admits of little rotary movement. The distal end of the radius is likewise of unusual structure, having a uniformly rounded and concave facet with possibly a slight styliform process. The radius articulates, in a freely rotating joint,

with the convex surface presented by the scaphoid and the greater part of the lunar.

The articulation between the proximal ends of the ulna and radius is similar to that of the proboscidians and the amblypods. The radius is strong as in the latter group and shares with the ulna the support of the body. A somewhat similar condition existed in the earlier macrauchenids though *Macrauchenia* itself had lost all rotary movement of the forearm.

The *manus* of *Astrapotherium* is quite similar to that of *Coryphodon* of the Amblypoda. The important differences as derived from direct comparison are (1) that in this genus the scaphoid and the lunar are closely apposed and present a continuous convex surface to the radius, while in *Coryphodon* the scaphoid and the lunar meet the radius in two distinct facets; (2) that the lunar in this genus presents a strong oblique facet on its postero-lateral surface to articulate with a second facet on the ulna; (3) that the cuneiform has a contact with metacarpal V. The distal row of carpals in this genus is essentially similar to that of *Coryphodon* except that the trapezium has contact with metacarpal II. The metacarpals of this genus increase in breadth from II to V; metacarpal I is equal in breadth to II but is much reduced antero-posteriorly. The phalanges are entirely unknown from the forefoot.

The *femora* are long, slender bones, laterally curved in the upper half of their length. The head of the femur is well constricted, the great trochanter relatively low, the lesser trochanter rises in an elongate but prominent crest. The shaft has a slight compound curvature in the antero-posterior direction. This feature, together with the backward extension of the condylar facets, indicates a great freedom of movement at the knee. The leg in the standing posture was apparently almost straight. The facet for the patella extends well forward on the shaft but is little elevated above its anterior surface. The femur figured by Gaudry, as above stated, is that of a contemporary homalodothere and is very different from that of this genus.

The *tibia* in its axial measurement is approximately three-fourths as long as the femur. It is broad at the proximal end but laterally compressed and angular in the upper half of the shaft, more rounded in the lower half. The cnemial crest is prominent, the facet for articulation with the fibula is well below the overhanging condyle. The distal articulation is irregularly convex and oblique to the axial direction of the shaft. The internal malleolus has a distinct facet

for articulation with the astragalus. The tibia of Gaudry's figure, referred to in connection with the femur, is so different from those of this specimen as to indicate that it was also erroneously referred to *Astrapotherium*. It is even more unlike that of the Santa Cruz *Homalodotherium*. For the present, this writer is unable to identify it.

The *fibula* is a slender bone, straight in the shaft, moderately expanded in the extremities, and has well-defined articular facets.

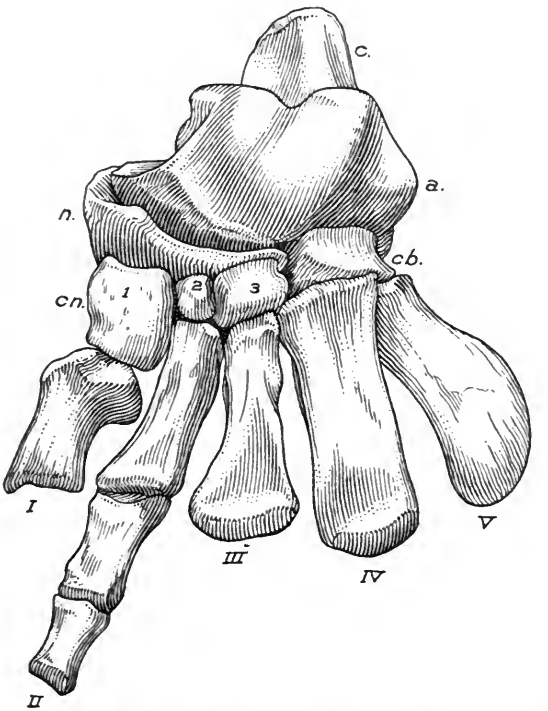

FIG. 38. Left pes of *Astrapotherium magnum*. F.M. No. P14251, x 1/3. *a.*, astragalus; *c.*, calcaneum; *n.*, navicular; *cb.*, cuboid; *cn.*, 1, 2, 3, cuneiformes; I–V, digits.

The relative length and position of femur, tibia, fibula, and pes are more like those of the North American amblypods than like those of any group of South American mammals. Apparently this similarity is only another case of parallel development.

The *pes* of *Astrapotherium* (fig. 38) is more elongate than that of *Coryphodon* and much more slender. The tarsals and metatarsals are less uniform in their size and strength. The digits are elongate as in the earlier amblypod genus, *Titanoides*. The astragalus is short and rounded in outline, its mesial and posterior margins

indented. The proximal facet covers almost the entire surface of the bone as is true of *Coryphodon*. The mesial surface bears two distinct facets for articulation with the internal malleolus of the tibia, separated by a narrow passage for blood vessels. The facet for the navicular covers the entire anterior surface; this facet is plane in the vertical axis but strongly convex in the lateral one. It meets the anterior facet for the fibula in a sharp angle; it is continuous with the facet for the cuboid. The two inferior articular surfaces are separated by a wide median fossa; the sustentacular facet is smaller than that for the calcaneum.

The *calcaneum* is relatively small and quite overshadowed by the astragalus in its position in the foot. The tuber calcis is short, vertically compressed and rugose throughout the plantar surface. Possibly there has been some vertical compression in the single specimen preserved, but little evidence of such distortion can be seen. The facets for articulation with the astragalus are both elongate and stand at a right angle to each other, separated by a deep pit in the angle. The facet for the cuboid is long and narrow but not well preserved in this specimen.

The *navicular* is a very thin bone, deep in its vertical dimension but appearing at the dorsal surface of the foot in the form of a wide crescent, very similar to this element in *Coryphodon*. It articulates proximally with the entire convex, anterior surface of the astragalus and articulates distally with the three cuneiform bones by three distinct facets.

The *cuboid*, as well as the ento- and mesocuneiform bones, is wedge-shaped and elongate in the dorso-plantar direction. The mesocuneiform is very much reduced, the entocuneiform is larger, the ectocuneiform is longer than the cuboid but not so broad nor so deep. In their proportions, these bones approach more nearly to the Paleocene *Titanoides* than to the later *Coryphodon*.

The *metatarsals* are more or less broken at their distal ends. They vary in size and in strength, the second and third being reduced while the fifth is expanded into a rugose lateral margin very much the same as in *Titanoides*. The inferior surfaces of the entire series of metatarsals are concave and apparently supported a heavy cushion upon which the animal walked. Only two phalanges of the pes are preserved. They are somewhat longer than wide. There is no evidence as to the unguals in this specimen, though they were probably very much reduced, in conformity with the size of the phalanges.

MEASUREMENTS

	Meters
Skull, length, premaxillaries to condyles	.650
Mandibles, crowns of incisors to condyle	.565
Atlas	
Breadth across transverse processes	.337
Antero-posterior breadth of superior arch	.062
Axis	
Length of centrum and odontoid process	.171
Antero-posterior breadth of spine	.134
Vertebrae	
Cervical, length of five centra	.330
Dorsal, length of nineteen centra in series	.990
Lumbar, length of five centra	.325
Sacral, length of centra	.245[1]
Scapula	
Greatest length	.485
Greatest breadth	.222
Breadth of acromion process	.184
Pelvis	
Total length	.520
Length from center of acetabulum to iliac crest	.350
Greatest breadth of ilium	.178
Humerus	
Axial length	.502
Greatest breadth of proximal end	.162
Greatest breadth of distal end	.117
Ulna, greatest length	.434
Radius, greatest length	.332
Third metacarpal, length	.081
Femur	
Greatest length	.558
Greatest breadth at distal end	.119
Tibia, axial length	.399
Fibula, greatest length	.373
Astragalus	
Antero-posterior diameter	.069
Transverse diameter	.071
Calcaneum	
Length	.098
Breadth	.066
Fourth metatarsal, length	.080
Patella	
Length	.080
Breadth	.049

[1] Estimated.

DISTINGUISHING CHARACTERS

The distinguishing characters of *Astrapotherium* as derived from the entire skeleton are: nasals short and nares wide; upper incisors wanting; canines long, angular in section and hypsodont; premolars reduced to two; molars lophodont in structure and increasing in size from 1 to 3; vertebral formula: cervicals 7, dorsals 19, lumbars 5, sacrals 5, caudals not known but probably not more than 15; ulna and radius equal in strength, head of radius notched into anterior

lip of sigmoid articulation; digits V–V, forefeet digitigrade, hind feet plantigrade and weak; ulna having contact with lunar, the cuneiform having contact with metacarpal V.

PROBABLE HABITS

Astrapotherium appears to have been a large-headed and long-bodied animal of the size of a bison. The dentition indicates habits of feeding upon low, moist-land plants. The padded feet also indicate a forest or meadowland habit. The occurrence of the fossils in a limited zone of the Santa Cruz beds and in a sandy, mud-bar stratum just above the marine Patagonian beds, suggests life in a lowland area. Likewise, the occurrence of remains of the Deseado (Oligocene) members of this family in the lagoon deposit at La Flecha and in channel deposits of the Deseado stage at Lake Colhue Huapi and other localities where specimens are found disarticulated, rolled, and water-worn, but seldom articulated, also indicates river deposition much the same as does the occurrence of *Metamynodon* in the channel deposits of the White River beds of North America. All this, together with a dentition fitted for feeding on lush vegetation, leads to the conclusion that *Astrapotherium* was a frequenter of lagoons and of river banks and that he was probably at home in the low grounds.

No attempt at fixing general relationships is made at this time. The astrapotheres have many characters in common with the litopterns, also they have many in common with the amblypods. Ameghino was inclined to class them in that order. It is hardly probable that the two groups, so widely separated geographically in their later history, could have relationships nearer than through some "protungulate" ancestry.

In accordance with a plan for placing various sections of the collections of South American fossil vertebrates in the hands of specialists best qualified to study them, the entire astrapothere material in Field Museum has been assigned to Professor William B. Scott for study and publication. This plan offers the surest guarantee for the careful study of a unique specimen and the most effective characterization of this little-known order of mammals.

FIG. 39. Skeleton of *Astrapotherium magnum*, No. P14251, as mounted in Field Museum. From photograph, x 1/14. Restored parts not indicated.