A NEW HORNED RODENT FROM THE MIOCENE OF KANSAS.

By James Williams Gidley,

Of the Department of Geology, United States National Museum.

In 1902[a] Dr. W. D. Matthew described a new and most interesting Mylagaulid rodent, *Ceratogaulus rhinocerus*, from the middle Miocene beds at Pawnee Buttes, Colorado. The genus is especially distinguished by a pair of well developed horncore-like processes situated on the nasal bones, a most unexpected and unique character for a rodent and entirely unknown prior to Matthew's discovery.

While recently unpacking some boxes of Miocene fossils, which for a number of years have been stored away in the United States National Museum, a second specimen was found, representing a new but closely related genus in which nasal horns are even more prominently developed than in *Ceratogaulus*. This specimen, a nearly complete skeleton, was originally obtained by the late Mr. John Bell Hatcher, while collecting fossils for Prof. O. C. Marsh under the auspices of the United States Geological Survey, in 1885. It comes from the upper Miocene beds near Long Island, Kansas. Although obtained so long ago, the specimen when found had apparently not been unpacked since arriving from the field and was probably never examined by Marsh.

With this more complete material it is now possible to confirm some of Matthew's conclusions regarding the association of the material described by him, to determine more definitely the affinities of the family Mylagaulidæ, and to give a more complete knowledge of the osteological characters of this little known but interesting group of rodents.

I have been greatly aided in the preparation of this paper by having for comparison all the Mylagaulid material in the American Museum of Natural History collection, which was generously placed at my disposal through the kindness of Prof. Henry F. Osborn and Dr. W. D. Matthew.

[a] Bull. Amer. Mus. Nat. Hist., XVI, 1902, p. 291.

Family MYLAGAULIDÆ Cope.

This family was not well characterized by Cope, owing to the insufficient material known to him, but with the discovery of better specimens it has since been more adequately defined by Doctor Matthew as follows, in part:[a]

> The characters amply confirm Prof. Cope's separation of it as the type of a distinct family. Its place is among the Sciuromorpha, but without close relationship to the other Sciuromorph families, the nearest being the Sciuridæ. * * * The antorbital foramen is close to the zygomata, as in *Meniscomys*, instead of considerably anterior to it as in most modern rodents. * * * The family distinctions from the Sciuridæ are the great enlargement of the fourth premolar in the lower jaw and of a corresponding tooth in the upper one, with reduction and final disappearance of the teeth posterior to it, and the tendency to hypsodont teeth with closed enamel lakes.

To these characters may be added another, distinctive of the family, namely, the location of the origin of the long curved incisor of the lower jaw, which is situated within the coronoid process.

EPIGAULUS, new genus.

Generic characters.—More specialized throughout than any other Mylagaulid hitherto described. True molars much more reduced than in *Ceratogaulus*, with a corresponding increase in size of the large grinding premolars. Premolars and probably molars completely surrounded by a band of cement which is a functional part of the tooth. Nasal horn cores placed much farther back than in *Ceratogaulus*, their posterior borders being on a line with the anterior borders of the orbits. Nasals extend correspondingly farther back to a point nearly opposite the posterior border of the orbits.

Type of genus.—*Epigaulus hatcheri.*

EPIGAULUS HATCHERI, new species.

Type.—A nearly complete skeleton (Cat. No. 5485, U.S.N.M.). From the upper Miocene beds[b], near Long Island, Phillips County, Kansas.

Specific characters.—Size somewhat larger than any species of the Mylagaulidæ described. Horn cores high and pointed, their height equaling one-third the entire length of the skull. Width of occiput greater than that of the zygomatic arches. Enamel lakes in the premolars numerous, seven in number in the upper and nine in the lower in the type. Fore limb and foot highly modified for digging, the foot being armed with heavy, compressed claws of great length. Hind foot long and slender, with the outer two digits, IV and V, the heav-

[a] Memoirs Amer. Mus. Nat. Hist., I, Pt. 7, 1901, p. 377.

[b] According to Hatcher's field label: "From a calcareous sand layer 10 feet above the bone layer." The bone layer referred to is the famous quarry near Long Island, Kansas, which has yielded such quantities of Teleoceras remains.

iest. Tibia greatly modified and twisted laterally, throwing the long axis of the foot inward at nearly a right angle to the fore-and-aft plane of the leg.

Measurements for comparison with those given by Matthew for Ceratogaulus.

	Mm.
Length of skull	80
Width across arches	64
Width of occiput	75
Height of horn core	32
Length of horn core at base	17
Conjoined width of horn cores	28
Width across postorbital processes of frontals	27
Width across postorbital ridges (at narrowest point)	20
Depth of zygomatic arch beneath orbit	10
Length of diastema	23
Length of three upper cheek teeth	20
Length of upper p^4	13
Width of upper p^4	8
Length of lower jaw	62
Depth of lower jaw beneath molars	19
Height of lower jaw, angle to tip of coronoid process	44
Length of three lower cheek teeth	20
Length of lower p_4	15
Width of lower p_4	7

Detailed description and comparisons.—The skull viewed from below has about the proportions of that of *Ceratogaulus*, but the broader and more extended nasals, the more backwardly placed horn cores, and more broadly expanded occiput give to the upper part of the skull a markedly different appearance. The top of the cranium (Plate LIX, fig. *b*) is broad and saddle-shaped, the postorbital crests converging but slightly as they run backward to the occiput. The zygomatic arches are heavy and deep, with prominent postorbital processes. The postorbital processes of the frontals are less prominent than in *Ceratogaulus* or *Mylagaulus*. The infraorbital foramen is moderately large, piercing the broad anterior border of the zygomatic arch in much the same manner as in the existing genus *Aplodontia*. The squamosal expands postero-externally, sending a process outward and downward, which becomes visible on the occiput partially inclosing the posterior portion of the mastoid, as in *Aplodontia*. This character is also observable in the Spalacidæ and some members of the Sciuridæ. The base of the skull (Plate LX, fig. 1) shows some striking resemblances to that of *Aplodontia* (Plate LX, fig. 2) especially in general form and proportions and the arrangement of the foramina. The wings of the pterygoid and alisphenoid are subequal in size, with a shallow intervening fossa. The posterior opening of the alisphenoid canal is a well-rounded foramen, opening downward. The foramen rotundum and foramen ovale pierce the alisphenoid bone in *Epigaulus* and *Aplodontia*, and the infraorbital foramen is similarly placed in both genera. In the characters as enumerated both the Aplodontidæ and Mylagaulidæ differ from the beavers and squirrels.

The palate is very narrow between the large premolars, widening more rapidly forward than backward. The space between the premolars and incisors is comparatively short, with the premaxillaries broadly rounded. The incisive foramen is placed well forward, as in *Aplodontia*.

The symphysis of the lower jaw (Plate LVIII, fig. *b*) is small and short. The jaw is heavy and deep in the region of the grinding teeth. The angle, as shown in Plate LXIII, fig. *g*, is broadly expanded and inflected, but to a less degree than in *Aplodontia*. The coronoid is comparatively high and straight, and is placed well back, capping the base of the long, curved incisor. The condyle is small with a long neck and irregularly rounded head.

The vertebræ.—The vertebral formula is, cervicals 7, dorsals 13, lumbars 6, sacrals 5, caudals ?. The vertebræ (Plate LXV) are comparatively short and heavy throughout, and the spinal column is greatly curved, as in the beaver. The atlas (Plate LXIII, fig. *c*) is unusually high and bears a short but well-defined spine. The posteriorly placed tranverse processes are blunt nodules of bone. The axis (Plate LXIII, fig. *d*), is short and carries a high, robust spine, which is widest antero-posteriorly at the base, but narrows rapidly and becomes widest transversely at the summit. The other cervicals in the type are only represented by fragments, but enough remains to show that the zygopophyses are broad and flat and considerably overlap each other in the same vertebra, indicating a considerable degree of flexibility of the neck. The first nine dorsal vertebræ have long, slender spines, but from this point they pass abruptly to the shorter, erect, heavy spines of the lumbar region.

The sacrum (Plate LXI, fig. *a*) does not differ materially from that of *Mylagaulus*, but is somewhat shorter, its attachments with the ilia are not extended so far forward and the vertebræ are even more completely fused. In both genera the first sacral is much the largest. The manner of fusion of the sacrum with the pelvis is suggestive of some of the modern Edentates, although it is nearly paralleled in *Spalax* and some species of the Geomyidæ (*Geomys floridanus*). The first two sacrals are anchylosed solidly with the ilia, the third is free, while the transverse processes of the posterior two vertebræ are completely fused with the anterior portion of the ischium, thus forming a large supra-acetabular foramen on either side.

The ribs, probably thirteen in number, are comparatively heavy throughout, their length and curvature indicating a large and well-rounded thorax. The first and ninth, or tenth, ribs are shown in Plate LXIV, figs. *b* and *c*.

The clavicles (Plate LXIV, fig. *g*) are very large, with heavy expanded ends for the cartilaginous attachments of the scapula and sternum.

There are three elements of the sternum preserved in the type (Plate LXIV, fig. *f*), including the presternum. This element is a comparatively large, irregularly shaped bone, with the transverse diameter somewhat exceeding the antero-posterior. Its ventral face is not keeled, and its thick anterior border presents a wide, shallow notch between the clavicles. In form and general proportions the presternum is curiously like the presternum or manubrium in the human skeleton. The remaining two elements, sections of the mesosternum, are very much smaller than the presternum, and are short and thick.

The bones of the fore limbs and feet are short and massive throughout, and are greatly modified. The scapula (Plate LXIII, fig. *a*, and Plate LXIV, fig. *a*) is large and Aplodontia-like in form. The spine is high, thin-edged, and bears a moderately well-developed matacromion. In *Castor* the spine is thick-edged and slopes rapidly from the acromion in a nearly straight line to the upper scapular border. The acromion is broken away in the type specimen. The glenoid cavity is shallow and continuous, with the anterior face of the heavy downwardly curved coracoid process.

The humerus, Plate LXI, fig. *c*, is short and massive, with its processes and ridges well developed for strong musclature. The great tuberosity extends well above the head of the humerus. The deltoid ridge is low but extends far down the humerus, ending in a strong spur-like process well below the middle point of the shaft. In *Ceratogaulus* this process is situated just below the middle of the shaft. In *Aplodontia* it is a little above that point. The supinator ridge is thin and very broadly expanded. This, together with the unusually well-developed condyles, gives a great breadth to the distal end of the humerus, which equals nearly one-half its entire length. There is present a large entepicondylar foramen, as in the Aplodontidæ and Sciuridæ.

The forearm, as compared with most other rodents, is unusually short, the shafts of the radius and ulna being only two-thirds the length of the humerus. The total length of the ulna, however, somewhat exceeds that of the humerus, owing to the great development of the olecranon. The shaft of the radius is small and round proximally, but is much expanded laterally at the distal end. The distal end of the ulna extends considerably below the end of the radius, as shown in Plate LXII, fig. *a*.

The only elements of the carpus preserved in the present specimen are the scapho-lunar and unciform. These are broad and thin, indicating a broad, short carpus. The metacarpus and proximal digits indicate also a very short and broad fore foot. The stout, heavy phalanges are armed with remarkably long well-developed digging claws. The first digit is much reduced, but is still functional and bears a long, slender claw. The metacarpals are strongly keeled distally on their inferior faces, but the articular facet is very limited superiorly and locks solidly with the proximal phalanx when fully extended. This, together with a similar construction of the other phalanges, constitutes an arrangement of the foot, as a whole, unparalleled in any other group of rodents. The toes were capable of extreme flexing, but this perfect locking prevented them from reflexing except to a limited degree, as shown in Plate LXIV, fig. *e*. The claws thus permanently held in a curved position, together with the slight rotary motion possible to the radius and ulna, indicate that the animal walked on the outer side of the foot, with the claws turned inward in a manner somewhat similar to the Great Anteater. This position of the foot probably explains also the unusually great extension of the distal end of the ulna below that of the radius.

In the Spalacidæ the general proportions of the bones of the fore limb, except the scapula, are very similar to those of *Epigaulus*. The humerus has much the same modifications as the latter, but there is no entepicondylar foramen present in the forms examined. The radius and ulna also are of similar proportions, and the olecranon is long and stout. But the scapula is very unlike in its proportions, being much more slender than in *Epigaulus*.

The fore foot of *Epigaulus*, with its short digits and long heavy claws, suggests especially the highly modified foot of the Asiatic genus *Siphneus*, now called *Myotalpa*, but judging from the figures published by M. Alphonse Milne-Edwards[a] the distal articular facets of the metacarpals are not limited superiorly as in *Epigaulus;* hence the toes have more flexibility, and the foot also appears to come naturally into the usual plantigrade position assumed by most rodents in walking.

Compared with the *Mylagaulus* pelvis described by Matthew[b] the ilia diverge more anteriorly, and the attachment of the sacrum does not extend so far forward. (See Plate LXI, fig. *a*). The ischium is short, with a heavy tuberosity; the light pubes are connected by a slender rod-like symphysis, and the obturator foramen is large and broadly oval in outline. The pelvis, as a whole, resembles the pelvis of *Aplodontia* more than that of any of the other living forms examined, but it is comparatively shorter and of generally more robust proportions. A striking peculiarity of the pelvis is that it is placed at a much greater angle to the line of the vertebral column than is usual in rodents.

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[a] Recherches pour servir à l'histoire naturelle des Mammifères. Paris, 1868 to 1874 pl. IX*b*.

[b] Mem. Am. Mus. Nat. Hist., I, Pt. 7, 1901, p. 379, fig. 6.

The hind limbs are lighter and more delicately proportioned than the fore limbs. The femur is nearly straight, with a rather slender shaft, but with well-developed trochanters and broadly expanded condyles. The greater trochanter extends somewhat above the head of the femur and is confluent with the greatly expanded third trochanter. The condyles are presented well backward. The surface for the patella is also unusually broad.

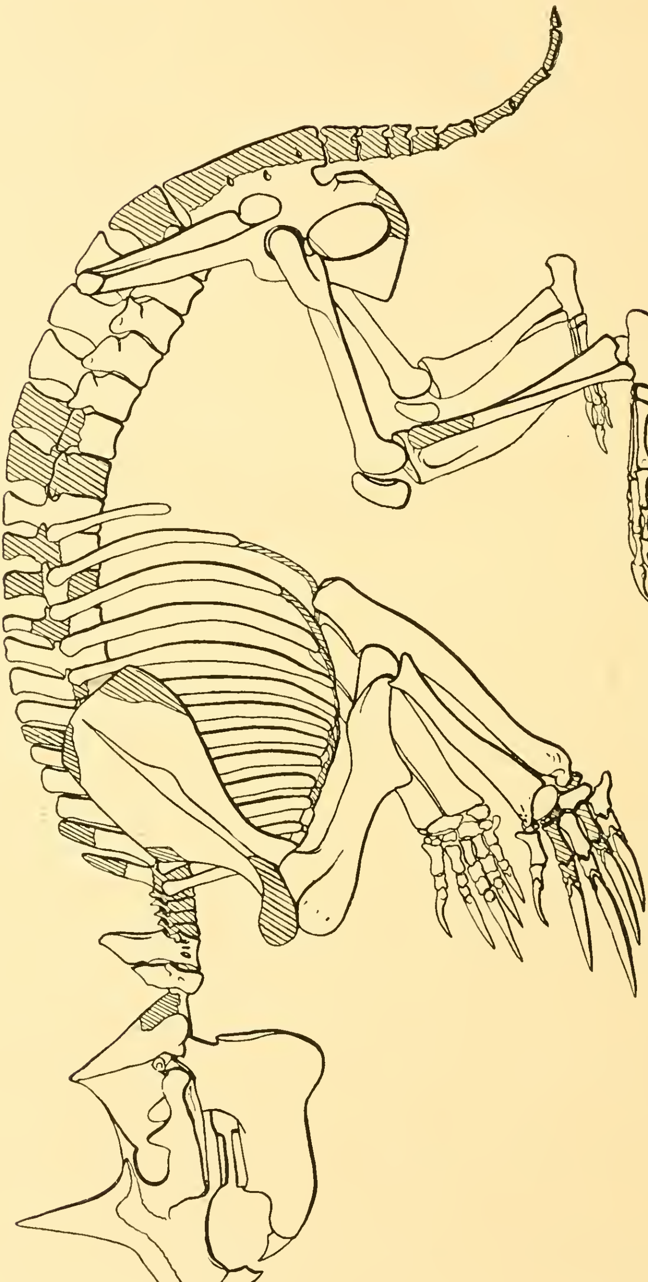
The tibia is comparatively short, not equaling the femur in length, and is remarkably modified. The cnemial crest is greatly expanded and extends well down the shaft, converting the proximal two-thirds into a thin expanded sheet of bone, deeply concave on the outer or fibular side and convex on the inner face. The entire shaft is greatly twisted laterally, as shown in Plate LXII, fig. *c*, the distal end being turned to such a degree as to carry the fibular facet to a position nearly in front, with the median ridge of the tibio-tarsal facet placed nearly at a right angle to the fore and aft plane of the tibia. This arrangement throws the foot inward at a great angle, with its outer side presented nearly forward when the tibia and femur are placed in the usual normal position. In *Mylagaulus* the tibia is apparently less modified.

The fibula is entirely free but much reduced. A considerable extent of the distal end of the shaft comes in contact with the tibia, as in *Aplodontia*.

The hind foot is wholly plantigrade and comparatively primitive. The toes, five in number, are long and slender, bearing small, delicately formed claws. The principal modification of the foot consists in the greater development of the two outer digits, IV and V, which are nearly equal in functional importance (see Plate LXIII, fig. *e*), and are much stouter than the others, suggesting the modification in the hind foot of some of the marsupials, especially the wombat. The cuboid is also unusually large and broad.

This most extraordinary twist of the tibia and consequent peculiar position of the hind foot is so radically different from that of mammals in general as almost to appear abnormal, but a possible explanation seems to suggest itself in the manner in which the foot may have been used. The fore feet and limbs so highly specialized and modified for digging, indicate that the habits of the animal were fossorial to a high degree. The principal function, therefore, of the hind limbs and feet may well have been for the purpose of removing the earth loosened and thrown backward under the body by the enormous claws of the fore feet. For this purpose the feet could be most effectively used in the position above indicated, and the outer toes thus being employed for the greater amount of work would naturally be the more strongly developed.

The outline restoration, figure (p. 634), was made from careful measurements of the bones, and indicates fairly well the general char-



Restoration of Epigaulus hatcheri. (About one-half natural size.)

acteristics and proportions of the skeleton of *Epigaulus hatcheri*. The animal, as a whole, seems to have been especially adapted to digging, for which occupation it was far better equipped than any of the gophers. The highly modified feet and unusually small orbits suggest that the animal may have lived almost exclusively under ground.

Questions of interest naturally arise in regard to the true meaning and possible utility of the great nasal horns. What is their real significance, and of what use could they have been to a burrowing rodent? Since such a development has no parallel in any of the living forms, any attempted solution of these questions must necessarily be based on conjecture. They may have been possessed by the males only, and in that event were probably used principally as fighting weapons. The discovery of more material will probably settle this point, and the question as well of whether the horns are peculiar to certain genera only, or are characteristic of the entire family. In any case they seem intended for use rather than for ornament, for they are strongly built and the whole skull is strengthened to resist severe strains placed upon them. The occiput, too, is broadly expanded for the attachment of heavy muscles, which would have enabled the animal to use the horns with great power. It seems not at all improbable, therefore, that they were utilized for burrowing. They may well have served as auxilliaries to the great claws to assist in rapid digging. This suggestion is borne out by the fact that the horns are closely twinned, making them especially effective as digging implements, and the tips of the nasals show signs of being protected by callosities, at least, if not by a second incipient pair of horns, suggesting that the nose often came in contact with the walls of the burrow.

Conclusions.—It seems evident from the above study that while this extinct group of highly specialized rodents apparently has some remote affinities to the Castoridæ and a somewhat nearer relationship to the Sciuridæ, as pointed out by Matthew, the family has a far greater number of characters in common with the Aplodontidæ, and shows besides some striking resemblances of general proportions to some of the Asiatic forms of the Spalacidæ. The resemblance to the latter family, however, seems to be due more to modifications of the skeleton for a similar special adaptation to burrowing habits than to any real relationship. In tooth development, the Mylagaulidæ have surpassed in specialization all other families of the Sciuromorpha, and could not have been ancestral to any of the living forms.

The affinities of the Mylagaulidæ to any of the known fossil forms is somewhat doubtful. Matthew and Peterson have suggested a possible relationship to *Euhapsis*, but the genus *Euhapsis* shows many more characters of the Castoridæ, and is more properly referable to that family.

EXPLANATION OF PLATES.

Plate LVIII.

Epigaulus hatcheri (natural size).

a. Skull, anterior view.
b. Skull and lower jaw, side view.

Plate LIX.

Epigaulus hatcheri (natural size).

a. Lower jaw, crown view.
b. Skull, superior view.

Plate LX.

Fig. 1. *Epigaulus hatcheri.* Skull, palate view (natural size).
2. *Aplodontia rufus.* Skull, palate view (natural size).

Plate LXI.

Epigaulus hatcheri (natural size).

a. Pelvis, superior view.
b. Right femur, anterior view.
c. Right humerus, anterior view.

Plate LXII.

Epigaulus hatcheri (natural size).

a. Right radius and ulna, outside view.
b. Right fore foot, superior view (with median digit supplied from the left fore foot).
c. Right tibia and fibula, inside view.
d. Right hind foot, superior view.

Plate LXIII.

Epigaulus hatcheri (natural size).

a. Left scapula, inferior view.
b. Left femur, posterior view.
c. Atlas, anterior view.
d. Axis, anterior view.
e. Cuboid, and metatarsals IV and V, superior view.
f. Left lower jaw, outer view.
g. Posterior portion of right lower jaw, outer view.

Plate LXIV.

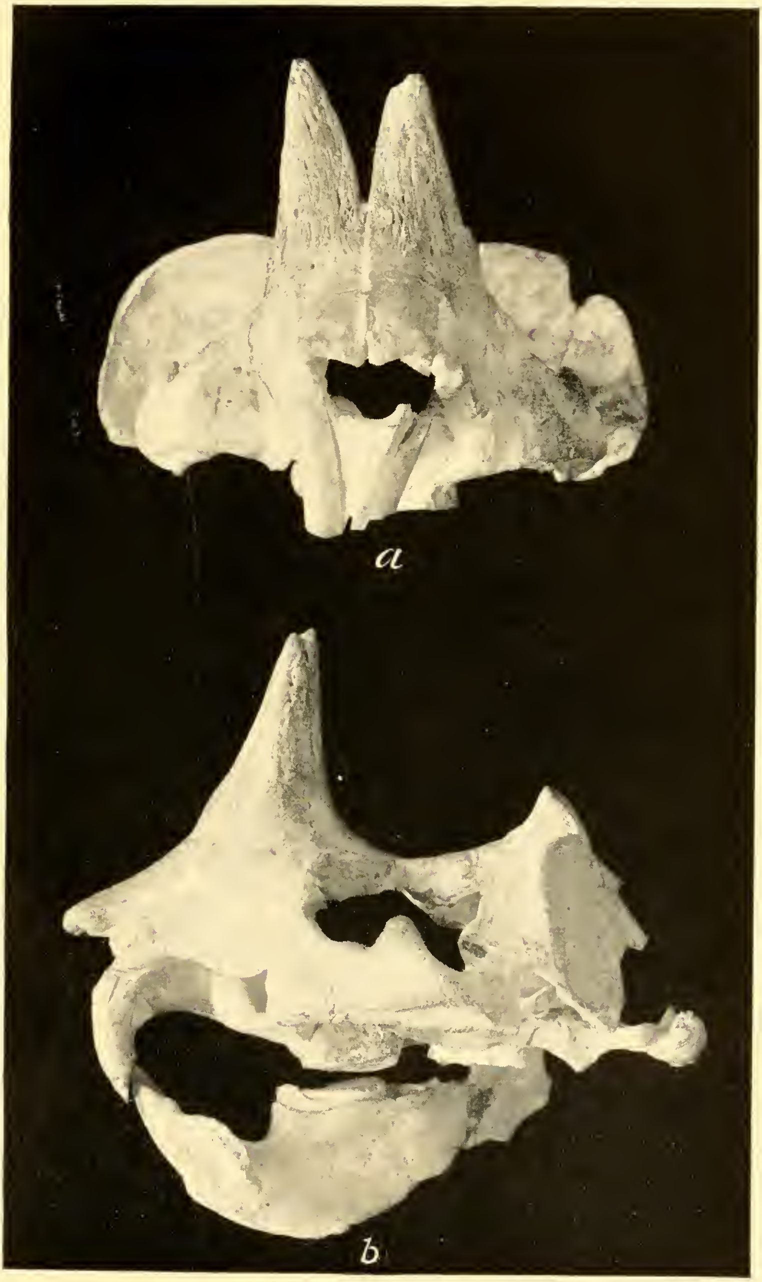
Epigaulus hatcheri (natural size).

a. Left scapula, outer view.
b. First rib of left side.
c. Ninth or tenth rib of left side.
d. Calcaneum of left hind foot.
e. Median digit of left fore foot, side view.
f. Presternum and two elements of mesosternum, inferior view.
g. Clavicle of left side.

Plate LXV.

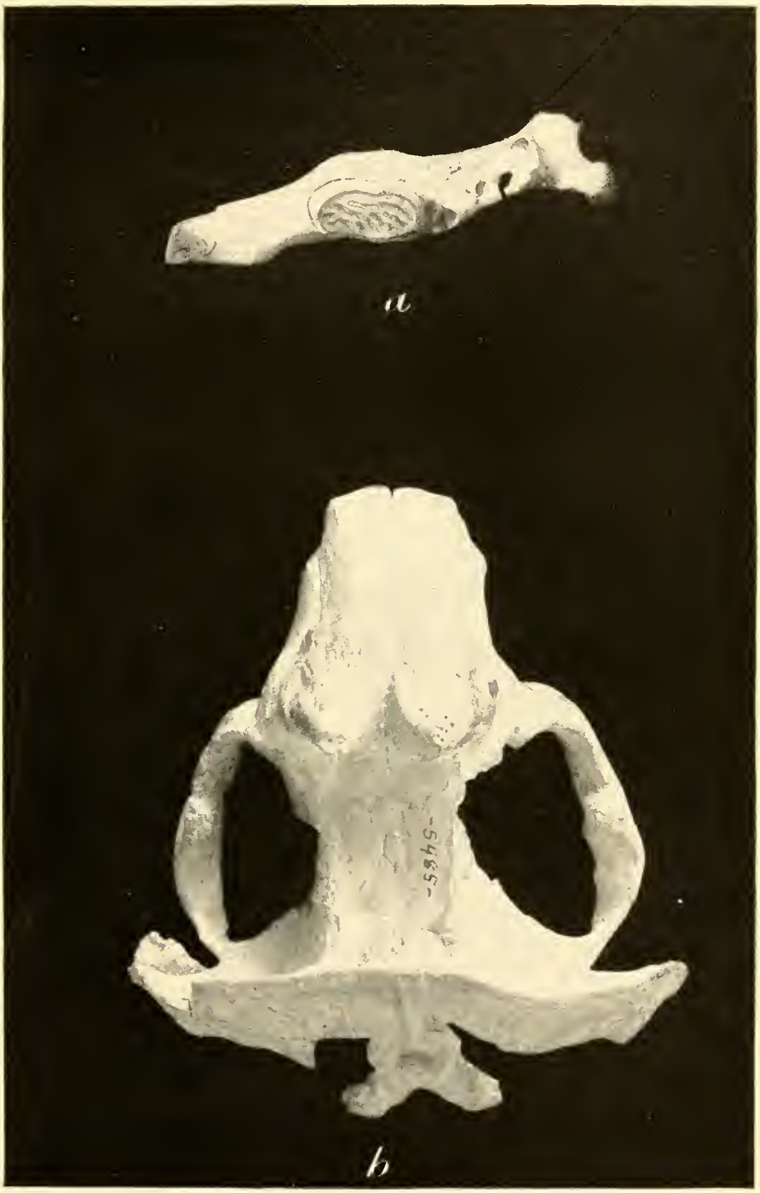
Epigaulus hatcheri (two-thirds natural size).

Vertebral column and pelvis, side view.



SKULL OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.



SKULL AND LOWER JAW OF EPIGAULUS HATCHERI.

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SKULLS OF (1) EPIGAULUS HATCHERI AND (2) APLODONTIA RUFUS.

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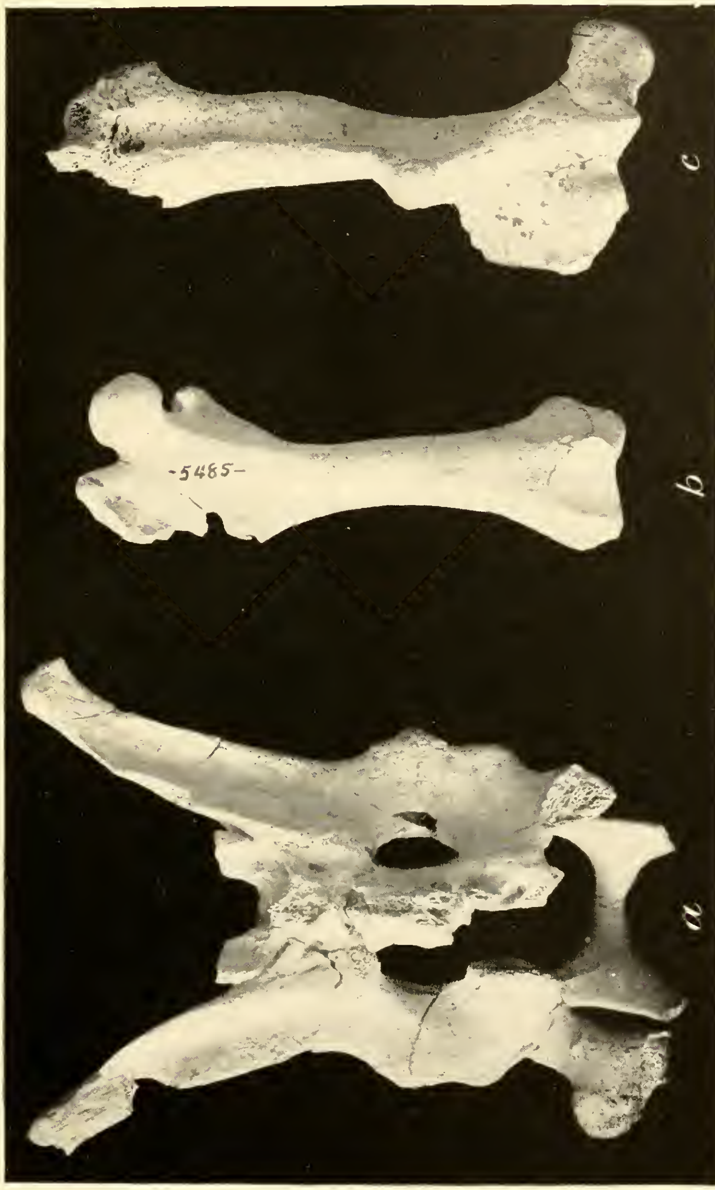

PELVIS, FEMUR, AND HUMERUS OF EPIGAULUS HATCHERI.

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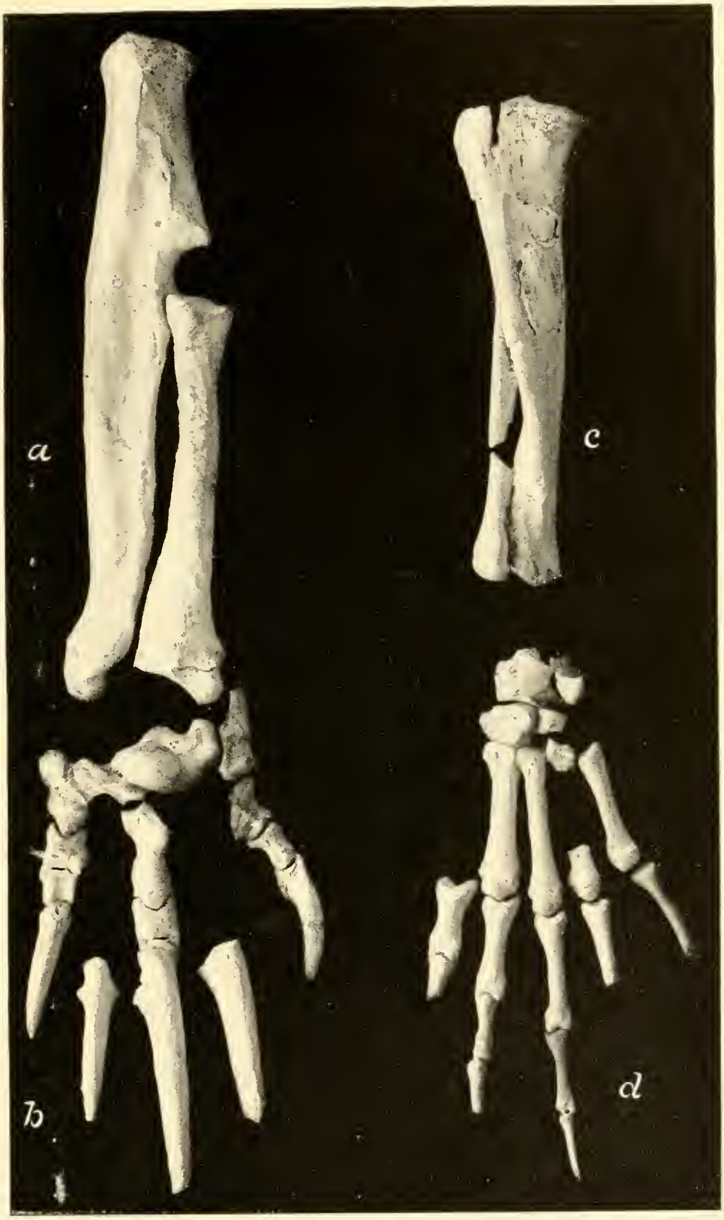

FORE AND HIND FOOT OF EPIGAULUS HATCHERI.

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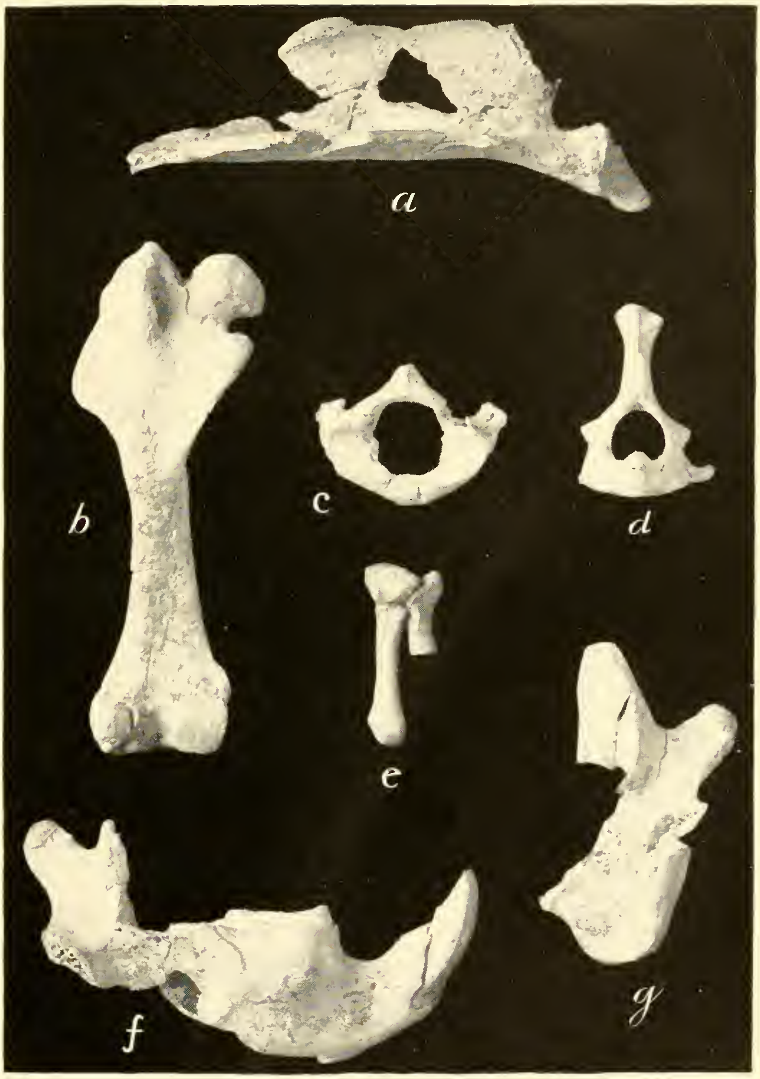

LOWER JAW AND SKELETON BONES OF EPIGAULUS HATCHERI.

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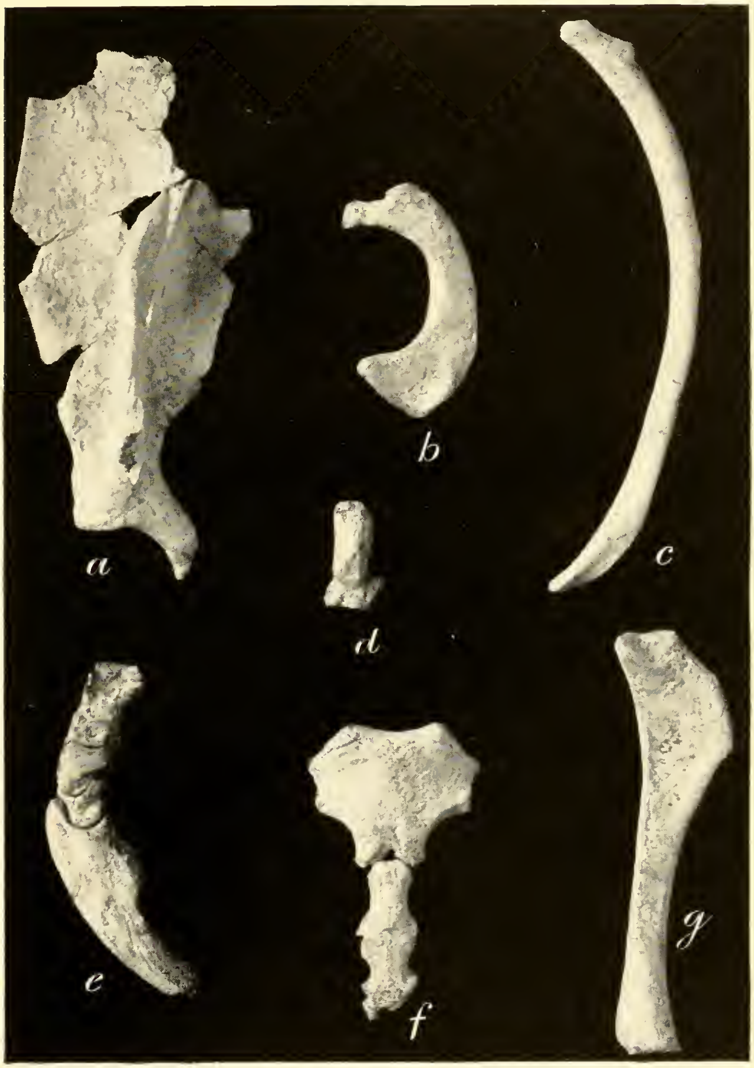

SKELETON BONES OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.

VERTEBRAL COLUMN AND PELVIS OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.