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A comparative study of the osteology and myology of the hind limb of the pocket gopher and kangaroo rat

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A COMPARATIVE STUDY OF THE OSTEOLOGY AND MYOLOGY OF THE HIND LIMB OF THE POCKET GOPHER AND KANGAROO RAT

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INTRODUCTION

The pocket gopher, Thomomys umbrinus (formerly bottae), and the kangaroo rat, Dipodomys ordii, were selected for a comparative study of the osteology and musculature of the hind limb. This selection was made because these two species are considered closely related phylogenetically. However, they are very different when considered from the viewpoint of general morphology, habitat and habits.

Very little literature was found on the anatomy of the pocket gopher and the kangaroo rat which applied to this study. However, the literature which was found was very complete. More has been written on the pocket gopher, but only one work was found on the kangaroo rat.

The Anatomy of a Wood Rat by Howell (1926) was found to be useful because of its convenient grouping of the muscles of the hind limb. These muscles were grouped as to function and location. It also includes illustrations of the muscles and bones.

Hill (1937) gives a complete description of the bones and musculature of the pocket gopher, and this paper was used as a guide to check the dissection as to origin, insertion and location.

Scheffer (1931) reports on the habits, environment and economic status of the pocket gopher, thus this work was useful in determining the uses made of the hind limb by this animal.

The work done on the thoracic limb of the pocket gopher and kangaroo rat by Allen (1950) was important as a guide in methods and procedures.

Fitch (1948) fully describes the kangaroo rat as to habitat, eco-

nomic importance and habits. The mode of locomotion and other adaptive uses of the hind limb are included.

The only literature found on the anatomy of the hind limb of the kangaroo rat was that written by Howell (1932). This work was used as a guide in my dissection. Howell describes the entire anatomy of the kangaroo rat as it compares to the jerboas.

METHODS AND PROCEDURES

A. Areas and Methods of Collection

The kangaroo rats were all collected from the Uinta Basin, which is located 30 miles south of Vernal, Utah. Live traps were used to collect the specimens, with oatmeal used as bait.

The traps were set in the evening and collected early the following morning. These animals were collected for the author by Dr. C. Lynn Hayward, of the Zoology Department.

The pocket gophers were collected from the area south of Springville, Utah. The California Gopher Trap was used in collection. The traps were placed in the burrow openings and firmly anchored. No bait was used as these traps work on the basis of a tripping mechanism. Light enters the rear of the trap and as the gopher enters to investigate he is caught.

These traps were set in the afternoon and checked every hour for animals. Elvis Holt supplied the author with the pocket gophers.

B. Laboratory Techniques

After collection, the specimens were placed in a deep freeze until needed for dissection. At this time they were brought to the laboratory, where they were skinned, eviscerated, beheaded and placed in the preservative. The preservative used was that found to be suitable by Allen (1950). It left the muscles flexible and soft, yet they did not tear apart easily. The following mixture was used:

70 ml. Ethyl Alcohol

10 ml. Glycerine

20 ml. Ammonium Hydroxide (concentrated)

After a few days in the solution the muscles were found ready for dissection. First, the volumetric displacement was taken of the total body volume without the viscera. Second, the general morphology was studied; third, pictures were taken of the superficial muscles; fourth, the muscles were measured by linear measurements and volumetric displacement; fifth, the muscles were removed one at a time in order for the origins and insertions to be seen; sixth, notes were taken as to origins and insertions. Pictures were taken of the deep muscles as dissection proceeded.

The bones were then prepared for study and photography. The method used for the preparation of the bones was the "Ammonium Hydroxide Method". This consisted of soaking the bones in concentrated ammonium hydroxide for a week to ten days, then boiling the bones in a soap and water solution for three or four minutes. The bones were then removed from the boiling water and held under a gentle stream of cold water to remove the remaining bits of flesh. A brush was used, gently, to clean the bones thoroughly as they were held under the stream of water. They were then placed in the sun to dry, and the bones of the foot were placed out straight to prevent curling

when drying occured.

The volumetric measurements were accomplished by using graduated flasks of appropriate sizes. The muscles were placed in water in the flasks and their displacement taken. The specimens were preserved in comparable volumes of the same solution so the water withdrawn from the preservative was the same for all specimens. The muscles were kept moistened during dissection, but care was taken not to saturate them.

The volumetric displacement of the total body volume, without the viscera, was taken, then as dissection proceeded the muscles and muscle groups were measured. The displacement of the very small muscles were not taken due to the possibility of error in reading their displacements.

The linear measurements were accomplished by means of a caliper. The muscle was measured by a caliper and then placed on a metric scale where the measurements were given in centimeters. The same method of linear measurements was made of the bones. The measurements made were for comparison of the morphology of the two species.

The terminology used in the descriptions of the muscles and bones is that as determined in Nomina Anatomica (1956), or the commonly used English equivalents.

Photographs were taken of the muscles and bones. The negatives were then placed in a slide projector and the pictures traced. Exact comparisons were not made due to the difficulty involved in photographing them.

The actions of the muscles were determined by studying the muscles as to location. The bones were also studied to ascertain the action the muscles would have with their respective origins and insertions. Thus,

the main actions of the muscles could be seen. Comparisons with the anatomy of the cat and man were used.

OSTEOLOGY OF THE HIND LIMB

A. Pocket Gopher

The os coxae is long and narrow and attached to the sacrum, which is fused. The sacrum in turn is attached to the lumbar vertebrae, craniad, which vertebrae are separate. All of the vertebrae have small stout spinous and transverse processes for muscle attachment. The sacrum and the fifth lumbar vertebra are attached to the ilium, firmly.

All of the bones of the pelvic girdle are thoroughly fused. The ischium and ilium are both long in relation to the body length. The pubis forms the entire ventral border of the hip bone, and the pubic symphysis is very thin and the arch wide.

The ischium forms the dorsal and caudal parts of the hip bone. It has an ischial tuberosity which is divided into two parts--the dorsal and ventral portions, joined by the caudal border. The dorsal tuberosity is the larger and projects dorsad to the rest of the hip bone and laterally. The ventral tuberosity marks the ventral limits of the hip bone and extends caudally. In all probability, the ventral tuberosity marks the end of the ischial ramus. The ischium extends craniad approximately to the iliopectineal eminence.

The ilium is a slender bone which extends from the acetabulum craniad. At the cranial end it is pointed and thickened, which part is termed the crest and tubercle. There is an iliac ridge which runs from the acetabulum, craniad, to the tubercle and separates the gluteal fossa

(fossa gluteal), dorsad, from the iliac fossa (fossa iliaca), ventrad. There is also a tubercle on this ridge, very near the acetabulum, and dorsocaudal to this tubercle is a roughened area. The tubercle and roughened area are for the attachment of the Rectus femoris muscle.

The iliac fossa and gluteal fossa are excavated and form places of attachment for muscles. On the ventral border of the ilium there is a process which is termed the iliopectineal eminence, which also allows for muscle attachment. The dorsal and ventral borders of the ilium lie approximately parallel to each other most of their distance and are slightly convex.

There is an opening dorsal to the ventral border of the pubis which is the obturator foramen (foramen obturatum). This opening is slightly oval, being approximately 0.7 cm long and 0.3 cm wide. The obturator foramen lies ventral and caudal to the acetabulum.

The acetabulum is a depression for articulation with the head of the femur. It is a deep socket located dorsocranial to the obturator foramen and immediately caudad to the iliac crest. The opening is 0.3 cm wide and lies caudally in the innominate bone. The distance from the cranial end of the pelvic girdle is 1.6 cm; whereas, the distance from the caudal border of the ischium is 1.2 cm.

The width of the pelvic girdle at the widest part is 1.8 cm, which is the width across the dorsal tuberosities, and the length is 3.05 cm.

Fitting into the acetabulum and articulating with the hip bone is the head of the femur. The femur is a stout, short bone and the processes are large. The head of the femur is off the main shaft (collum femoris) in a craniomedial direction. The neck of the head is very short. The greater trochanter (trochanter major) is very large and projects in a slightly

lateral line, and dorsad to the head of the femur. Distal to the head of the femur is the lesser trochanter (trochanter minor). It is smaller than the greater trochanter but is very prominent. It comes off the shaft at almost a right angle and lies on the medial side.

Running from the greater trochanter to the lesser trochanter on the posterior surface of the femur is the trochanteric ridge (cresta trochan--terica), and between this and the head of the femur is a depression called the trochanteric fossa (fossa trochanterica). Just distal to the greater trochanter is a roughened area termed the gluteal tuberosity (tuberositas glutea), which is for insertion of the Gluteus maximus muscle.

Distad to the greater trochanter, running down the lateral side of the femur, is the lateral ridge (cresta lateralis). It extends approxi-mately half of the way down the shaft. At the distal end of the femur are the medial and lateral condyles (condylus medialis and condylus lateralis). Between the condyles, on the anterior surface of the femur, is the patellar groove, and on the posterior surface, between the enlarged condyles, lies the popliteal fossa.

The shaft is rounded and smooth other than the above mentioned points of muscle attachment. The femur is 2.4 cm long and is 0.6 cm wide at the condyles. The width at the proximal end is 0.65 cm.

The tibia and fibula are fused. The proximal two-thirds of the lower leg bone is divided except for the head of the tibia and fibula, which are solidly fused. The articulating surfaces for the femur are large. The medial condyle is slightly distal to the lateral. At the proximal end of the tibia is the tibial tuberosity (tuberositas tibiae), which is part of the common proximal epiphysis, and the large patellar tendon inserts on this tuberosity.

The cranial, interosseous and medial crests (margo medialis, margo anterior, and margo interosseous) are prominent. The cranial crest begins lateral to the medial condyle and runs approximately one-half of the way down the tibia. The crest projects laterally over the lateral fossa on the lateral surface of the tibia.

The medial crest begins distal and caudal to the medial condyle, becoming indistinct about one-third of the way from the proximal end. The proximal portion is very irregular and curves over the medial fossa. Between the medial fossa and lateral fossa is the interosseous crest, to which the interosseous membrane attaches.

The fibula, as has been stated above, is fused with the tibia at the head but is divided for about two-thirds of the length, at which point it again is fused with the tibia. It is a very small, thin bone lying caudal to the tibia, and its head forms part of the proximal epiphysis. The bone is flattened on the surfaces facing the tibia and caudally. It has an interosseous crest for attachment of the interosseous membrane. There are two ridges on the craniolateral surface of the tibiofibula, one distal and in line with the lateral crest and the other representing the margin of the fibula.

The distal end of the tibiofibula consists of the malleoli and an articular surface for the talus bone. The malleolus lateralis is large and the most distal portion of the bone; whereas, the malleolus medialis is less distinct. There is a groove on the malleolus lateralis, laterally, which serves for passage of the tendon of the Peroneus longus muscle. There is also, a large groove behind the malleolus lateralis which is for the passage of other tendons. There are two grooves on the anterior surface of the distal end of the tibiofibula. The malleolus medialis exhibits two more such

grooves and there is a large groove behind it. The distal end of the tibiofibula articulates with the talus. The tibiofibula is 2.55 cm long and the fibula is 1.4 cm long.

The tarsus contains eight bones, including the medial tarsal bone. The talus articulates with the tibiofibula. It has two condyles, the lateral condyle is much larger. The neck is short and the head large. There are two facets for articulation with the dorsal portion of the calcaneus, of which the lateral facet is larger and both are concave. The medial facet is small and divided from the lateral facet by a convex groove which articulates with the sustentaculum tali of the calcaneus and gives attachment for a ligament.

The calcaneus bone is approximately T-shaped, with the caudal end containing a groove for the tendon calcaneus. The distal end is concave and articulates with the cuboid bone. There is the sustentaculum tali which articulates with the talus and a lateral facet with a convex articular surface. The interosseous groove between the two serves as attachment. On the lateral side of the calcaneus is the large trochlea which has a groove on the lateral surface for the passage of the tendon of the Peroneus longus muscle. There is a large groove on the dorsal surface of this process for other tendons, while the plantar aspect also has a groove for the passage of tendons.

Os tarsale mediale is a very small bone lying medial to the talus. It is circular from the side and has flattened surfaces medially and distally. The os naviculare is also a very small bone which is concave at its proximal end to fit with the talus bone.

Ossa cuneiforme mediale, intermedium and laterale are the three cuneiform bones. The laterale is large and roughly rectangular. It is

larger and more convex distally. The intermedium is smaller and rhomboidal in its dorsal aspect. The mediale is also large and wedge-shaped.

Os cuboideum is somewhat triangular. It has a convex facet for articulation with the calcaneus. Distally there is a concave facet for articulation with the fourth metatarsal bone and a projection laterally for slight articulation with the fifth metatarsal. There is a deep groove on the plantar surface for the passage of tendons.

Ossa metatarsalia I-V are the metatarsal bones of the foot. The fifth is the smallest,with the first being slightly longer but more slender. The proximal surface of the first is concavo-convex for articulation with the lateralis cuneiform and the second metatarsal. The proximal end of the second is narrow and square, the shaft is more slender than those of three and four. The proximal ends of three and four are in an oblique plane. The third has a process on the shaft for articulation with a depression in the fourth. The fifth is stout with a large lateral tuberosity. The heads of all the metatarsals are swollen and keeled.

The phalanges attach to the distal ends of the metatarsals and are very short, rounded bones. A claw is attached to each terminal phalanx. The middle digit is the longest.

B. Kangaroo Rat

The os coxae of the kangaroo rat is typical of that of most rodents. All of the bones of the innominate are thoroughly fused, so that it is impossible to state the exact limits of each bone.

The cranial part of the sacrum is attached to the innominate bone, forming the sacroiliac joint. None of the lumbar vertebrae are attached to the hip bone but attaches caudally to the sacrum. The vertebrae display very long spinous and transverse processes. However, the processes are thin and fragile.

The innominate bone is long and narrow, being 3.0 cm long at its longest portion. The width is 1.8 cm at the widest part, which is at the cranial tip of the ilium.

The ischium comprises the dorsal and caudal portions of the hip bone. The caudal portion is marked by the ischial tuberosity which is divided into two portions--the dorsal tuberosity and the ventral tuberosity. The dorsal portion is elevated above the rest of the ischium and its margin runs caudoventral to join the ventral tuberosity. The caudal ridge connecting the two portions is on a slant. There is also a ridge running from the dorsal tuberosity, craniad, to the acetabulum.

The ischium fuses caudally with the pubis bone. The pubis bones form a strong pubic symphysis where they attach to each other on the ventral surface of the hip bone. This symphysis is wide and long, forming a strong arch. The pubis bone also forms the ventral margin of the hip bone. This bone runs at an angle to the rest of the innominate, with the anterior end being more dorsal.

The anterior portion of the innominate is composed of the ilium, which extends from the acetabulum craniad. This portion is long and wide.

The ilium ends, cranially, in a curved, flared point. A large ridge (iliac ridge) runs from the crest at the anterior point caudad to the acetabulum and separates the gluteal fossa, dorsad, from the iliac fossa, ventrad. These areas are concave and well defined. Arising on the iliac ridge, just craniad to the acetabulum, is a large tubercle which is for the attachment of the Rectus femoris muscle.

On the ventral border of the ilium there is a small elevated area which forms the iliopectineal eminence, which also serves for muscle attachment. The ventral and dorsal borders of the ilium run approximately parallel to each other, however, the dorsal border is more irregular than the ventral.

The obturator foramen (foramen obturatum) is a large opening between the ischium and pubis. It lies at an angle with the anterior portion lying more dorsal and the posterior end being ventral. The opening is oval and is .89 cm long and 0.4 cm wide.

Immediately dorsocranial to the obturator foramen is the acetabulum. This is a deep socket for articulation with the head of the femur. It is 0.3 cm across and is round. The acetabulum is situated more caudally in the innominate bone, being 1.5 cm from the cranial end of the ilium and 1.25 cm from the most caudal portion of the hip bone.

The pelvic limb is attached to the innominate by the head of the femur, which fits into the acetabulum. The femur is 2.8 cm long and is a long, slender bone. The processes are very large and well defined. The head is attached to the shaft, proximally, by a long neck, which comes off the shaft at an angle. Next to the head is the greater trochanter which comes off the shaft slightly laterally and projects dorsad to the head of the femur. Distal to the head of the femur is the lesser trochanter, which

is smaller than the greater trochanter and lies on the mesial side of the femur. A short distance distal to the greater trochanter is another process, the third trochanter. It is a very prominent projection in the kangaroo rat and runs a short distance on the shaft of the femur.

On the posterior surface of the femur a well defined ridge is present, running from the greater trochanter to the lesser trochanter. Between the trochanteric ridge and the head of the femur there is a depression, the trochanteric fossa.

At the distal end of the femur are the medial and lateral condyles, which are rounded portions of the bone. Between the two condyles, on the anterior surface, there is a patellar groove with which the patella articulates. On the posterior surface the popliteal fossa lies between the enlarged ends of the condyles. Immediately craniad to the condyles, on the posterior surface, there are two small sesamoid bones. There is also a sesamoid bone at the distal edge of the popliteal fossa.

The shaft of the femur is regular, except for a slight ridge running from the lesser trochanter, distally, a short distance.

The tibia and fibula are fused at their heads and the distal two-fifths of the tibia. The proximal three-fifths of the lower leg bone is divided. The heads of the tibia and fibula are fused but the place of fusion is very distinct. The head of the fibula is slightly distal to the lateral condyle of the tibia to which it is fused.

The condyles of the femur articulate with the medial and lateral condyles of the tibia. The lateral condyle lies distal and is smaller than the medial condyle. There is a slight tuberosity on the anterior surface of the tibia at the common proximal epiphysis and it lies distal to the condyles.

On the tibiofibula the cranial, interosseous, and medial crests are very prominent. The cranial crest begins lateral to the medial condyle and runs less than half way distad on the tibia. It projects laterally over the lateral fossa, being very wide at the proximal end and diminishing as it runs distad.

The medial crest begins just distal and caudal to the medial condyle and runs distally less than one half the length of the tibia. It extends as far distad as the cranial crest, and projects over the medial fossa. The medial crest is very distinct for its entire length but is not as wide or clear as the cranial crest. The proximal portion is slightly irregular. Between the lateral fossa and the medial fossa lies the interosseous crest to which the interosseous membrane attaches. This crest is large and well defined.

The fibula is fused at the proximal end with the tibia, as was stated above. It is a very thin, slender bone and lies caudal to the tibia. It extends three-fifths of the way down the tibia where it fuses solidly. It is 1.9 cm long and the tibiofibula is 3.6 cm long. The fibula is flat on the surfaces facing the tibia and caudally, and is wider at its head and very narrow at the distal portion. It also has a slight interosseous crest for attachment of the interosseous membrane. After fusion the tibiofibula continues distally regular.

At the distal end of the tibiofibula there are the lateral and medial malleoli. These are projections for articulation with the talus bone. The lateral malleolus is the larger and extends distally slightly farther than does the medial malleolus.

There is a groove on the lateral surface of the lateral malleolus and a large groove behind it, which serves for the passage of tendons

There are two grooves on the anterior surface of the tibiofibula at its distal end. The medial malleolus has two more grooves on its medial surface and a large groove behind it.

The tarsus contains eight bones. They are: the talus, calcaneus, navicular, cuboid, three cuneiformes, and the medial tarsal bone. The talus is a large bone, being 0.3 cm wide. It articulates with the tibiofibula by two articulating surfaces--the medial and lateral condyles, of which the lateral is the larger. The trochlear process is pully-like and is dorsal to the rest of the bone. There are two facets for articulation with the dorsal portion of the calcaneus, both are concave. The talus bone exhibits no extraordinary variations from the talus bones found in other rodents.

The calcaneus is a very long bone, ventral to the talus. The heel protrudes extensively. The rest of this bone does not differ from the usual and has been described elsewhere in this paper. The remaining tarsal bones are in the same general shapes as for other rodents, but they are a little larger than those found in the pocket gopher. There is a lateral sesamoid bone on the medial tarsal bone.

The metatarsals are very long and rounded. They fit very close together and the distal ends are thickened and round, with a depression for articulation. There are five of these bones in the kangaroo rat, however, there is no hallux in the kangaroo rat. The phalanges are relatively long and in the regular shape. There are eight of these bones and to each terminal phalanx is attached a long claw.

On the plantar surface of the foot there are small sesamoid bones to which some of the tendons attach. The entire length of the foot is 3.5 cm, and the heel projects 0.4 cm from the talus, caudad.

MYOLOGY OF THE HIND LIMB

A. Pocket Gopher

M. Psoas minor (Figs. 1, 13)

Origin. This muscle arises from the first, second and third lumbar vertebrae.

Insertion. It inserts by a tendon upon the psoas process of the ilium, ventrad of the acetabulum.

Action. It flexes the pelvis and lumbar vertebral column.

Description. This muscle is long with a fleshy origin. It is tendinous as it passes caudad to its insertion and lies superficial to the Psoas major.

M. Psoas major (Figs. 5, 13)

Origin. It arises from the bodies and transverse processes of the last three lumbar vertebrae, first two sacral vertebrae and the ventral border of the ilium.

Insertion. The insertion is upon the lesser trochanter of the femur.

Action. This muscle flexes the femur and rotates it laterally.

Description. The Psoas major is a relatively thick muscle and lies deep to the Psoas minor.

M. Iliacus (Figs. 1, 5, 13, 15)

Origin. This muscle arises from the iliac fossa and the transverse process of the last lumbar vertebra.

Insertion. This muscle inserts deep to the Psoas major upon the lesser trochanter and upon the shaft of the femur.

Action. Flexes and laterally rotates the femur.

Description. This muscle is quadrilateral in shape and is large and thick.

M. Gluteus maximus (Figs. 3, 11, 15)

Origin. It arises from the vertebral column from the spines of the third to the fifth sacral vertebrae and from an aponeurosis which covers the Gluteus medius.

Insertion. The caudal part inserts by a tendon onto the gluteal tuberosity. The rest of the muscle inserts by an aponeurosis on the lateral ridge of the femur.

Action. Abducts, extends and laterally rotates the femur.

Description. This is a very broad, thin muscle which is rather in a shape of a fan from the caudal insertion. It lies superficial to the Gluteus medius.

M. Gluteus medius (Figs. 1, 3, 15)

Origin. This muscle arises in two portions. The more superficial layer originates from the spines of the first four sacral vertebrae, fascia, and crest and spine of the ilium, while the other part arises from most of the gluteal fossa of the ilium.

Insertion. The insertion is upon the proximo-medial part of the greater trochanter.

Action. Abducts the thigh.

Description. It is in the shape of a fan and is a very thick muscle. The superficial layer is separable from the deeper layer except at insertion and along the ventrolateral border.

M. Gluteus minimus (Figs. 1, 3)

Origin. This muscle arises from the iliac ridge and its inferior gluteal fossa. The ventral portion originates from an aponeurotic sheet which

arises from the inferior border of the ilium.

Insertion. It inserts by a tendon onto the greater trochanter of the femur.

Action. Abducts the femur.

Description. This muscle lies deep to the Gluteus medius and is very closely associated with it.

M. Gemellus superior (Figs. 1, 3)

Origin. Origin is from the cranial surface of the ischial tuberosity.

Insertion. It inserts on the tendon of the obturator internus and in the trochanteric fossa, in front of the tendon.

Action. Rotates the femur laterally.

Description. This muscle is small and lies ventral to the Gluteus medius.

M. Piriformis (Figs. 15)

Origin. It arises from the transverse processes of the second, third and fourth sacral vertebrae.

Insertion. It inserts with the Gluteus medius onto the greater trochanter of the femur.

Action. Rotates the thigh laterally.

Description. This muscle is closely associated with the Gluteus medius and is fan shaped.

M. Obturator internus (Fig. 3)

Origin. This muscle arises caudad to the obturator foramen on the pelvic surface of the ischium.

Insertion. It inserts by a tendon into the trochanteric fossa and crest.

Action. Rotates the femur laterally, extends the femur when flexed.

Description. This is a small muscle which inserts with the Gemelli.

M. Gemellus inferior (Fig. 1)

Origin. It arises from the ischial crest just above the quadratus femoris.

Insertion. Insertion is on the posterior side of the head of the femur.

Action. Rotates the femur laterally.

Description. It is a small thick muscle.

M. Quadratus femoris (Figs. 1, 15)

Origin. The Quadratus femoris originates from the ischial crest.

Insertion. This muscle inserts upon the posterior side of the upper femur just below the head.

Action. Rotates the femur laterally.

Description. This is a very short, thick muscle which lies next to the Gemellus inferior.

M. Obturator externus (Figs. 1, 3)

Origin. The origin is from the obturator membrane and the external border of the obturator foramen.

Insertion. This is very deep on the trochanteric fossa of the femur, by a tendon.

Action. Rotates the femur laterally and adducts it.

Description. The Obturator externus is a short, broad muscle which lies cranial to the Adductor minimus, deep to the Psoas major.

M. Semimembranosus (Figs. 1, 5, 13, 15)

Origin. It arises from the caudal border of the ischium and the ventral ischial tuberosity.

Insertion. It inserts by a tendon into the mediocranial surface of the tibia near its head.

Action. Extends the femur and flexes the shank.

Description. This is a broad, long muscle which lies proximal to the Gracilis

M. Semitendinosus (Figs. 1, 5, 11, 13)

Origin. The Semitendinosus arises from the spines of the last sacral and first caudal vertebra and from the dorsal tuberosity of the ischium.

Insertion. The insertion is by a flat tendon on the mediocranial surface of the tibia near the middle.

Action. Extends the femur and flexes the shank.

Description. The Semitendinosus is a long, narrow, thick muscle. It lies distad to the Semimembranosus.

M. Femorococcygeus (Biceps femoris anticus) (Figs. 1, 3, 11, 15)

Origin. The muscle arises from fascia and the ischial tuberosity near the Gluteus maximus insertion.

Insertion. The muscle inserts upon the patella and the most distal part of the femur.

Action. Flexes the shank.

Description. This muscle is also long, thin, and narrow.

M. Biceps femoris (Figs. 1, 3, 11, 15)

Origin. It seems to have two heads originating from fascia on the ischial tuberosity and along the ventral border of the hip bone, along with the Gracilis.

Insertion. It attaches to the dense fascia lata of the leg, also to the lateral surface of the head of the tibia.

Action. Flexes the shank and extends the femur.

Description. This is a very broad, thick muscle. It is superficial to the Caudofemoralis.

M. Rectus femoris (Figs. 1, 5, 11, 13, 15)

Origin. Originates by two heads very close together. The one arises from the roughened area craniodorsal to the acetabulum. The straight head is

from the iliac tuberosity.

Insertion. It inserts by the patellar tendon onto the patella and then onto the tuberosity of the tibia.

Action. Extends the shank and flexes the femur.

Description. This muscle is a large mass, cranial to the Vastus lateralis and Vastus medialis.

M. Vastus lateralis (Figs. 3, 11, 15)

Origin. The origin is from the greater trochanter of the femur, the cephalic surface of the lateral ridge and laterocranial surface of the femur.

Insertion. It inserts upon the aponeurosis of the Rectus femoris and on the laterodorsal surface of the patella, to the tibia.

Action. Extends the shank.

Description. The above muscle is difficult to separate from the other Vasti muscles. It is a thick mass of muscle.

M. Vastus medialis (Figs. 5, 13)

Origin. This muscle arises from the cranial and medial surfaces of the femur.

Insertion. It inserts with the Rectus femoris by the patellar tendon onto the patella and then to the tuberosity of the tibia.

Action. Extends the shank.

Description. This muscle is a mass which is difficult to separate from the Vastus lateralis. There is no division of the Vastus intermedius muscle.

M. Pectineus (Figs. 1, 5, 13)

Origin. The Pectineus originates on the ventral border of the pubis, craniad of the origin of the Adductor longus.

Insertion. It inserts with the Adductor longus on the medial surface of

the femur, midway.

Action. Adducts the femur and flexes it.

Description. This is a short, narrow, thick muscle immediately craniad to the Adductor longus.

M. Gracilis (Figs. 1, 5, 11, 13, 15)

Origin. From the ventral margin of the ischium.

Insertion. This is upon the anterior surface of the tibia, two-thirds from the bottom, proximal to the Semitendinosus.

Action. Adducts the femur and possibly flexes the shank.

Description. This muscle lies caudad to the Semimembranosus. It is relatively long and thin.

M. Adductor longus (Figs. 1, 5, 13)

Origin. It originates from the pubic bone, ventral margin.

Insertion . The insertion is by a tendon to the medial surface of the femur.

Action. Adducts the femur.

Description. A very short, small muscle which lies caudad to the Pectineus and craniad of the Adductor brevis.

M. Adductor brevis (Figs 1, 5, 13)

Origin. The origin is from the ventral margin of the hip bone, ventral to the obturator foramen.

Insertion. It inserts between the Adductor longus and Adductor magnus onto the middle half of the femur on the caudomedial surface.

Action. Adducts the femur.

Description. A broad, flat muscle which is thin. It lies caudad to the Adductor longus.

M. Adductor magnus (Figs. 1, 5, 13, 15)

Origin. It originates from the ventral border of the pubis, caudad to the

origin of the Adductor brevis.

Insertion. It inserts onto the surface of the femur, distad, up about two-thirds of the way.

Action. Adducts the femur.

Description. This muscle is thick but is long and narrow, staying about the same width its entire length.

M. Adductor minimus (Figs. 1, 3)

Origin. Its origin is deep to the Adductor brevis on the ischium.

Insertion. It inserts on the caudal surface of the lateral ridge of the femur. It lies close to the Adductor magnus and Quadratus femoris.

Action. Adducts the femur.

Description. A small muscle which is ventral to the Quadratus femoris and runs horizontally in contact with the Adductor magnus.

M. Adductor magnus proprius (Figs. 1, 3, 17)

Origin. This muscle originates from the area between the obturator foramen and ventral ischial tuberosity.

Insertion. It inserts upon the lateral ridge of the femur, distal to the insertion of the Adductor minimus, extending almost to the condyle.

Action. Adducts the femur.

Description. This is a short, thick muscle. It is bounded cranially by the Adductor minimus and Obturator externus; dorsally,by the Quadratus femoris; caudally,by the Semimembranosus and ventrally,by the Gracilis and Adductor brevis.

M. Caudofemoralis (Figs. 1, 5, 11, 13, 15)

Origin. The Caudofemoralis originates from the dorsal margin of the ischial border.

Insertion. Insertion is onto the medial epicondyle of the femur.

Action. Abductor of the femur.

Description. This is a thick, broad muscle which lies partially hidden by the Adductor magnus.

M. Gastrocnemius (Figs. 3, 5, 7, 11, 13, 15)

Origin. It originates by two heads from the medial and lateral condyles of the femur, by tendons.

Insertion. It inserts by tendons from both halves which unite and form the calcaneous tendon which attaches to the tuberosity of the calcaneus.

Action. Flexes the shank and plantar flexes the foot.

Description. A large, broad, thick muscle which is separated at the origins. The medial half is larger than the lateral.

M. Plantaris (Figs. 3, 9)

Origin. This muscle originates with the lateral head of the Gastrocnemius from the lateral condyle of the femur.

Insertion. Insertion is by a tendon onto the plantar aspect of the foot. The tendon divides and one goes to the middle digit and one goes to the fourth digit.

Action. Plantar flexes the foot, and flexes the shank.

Description. The above muscle is large in the pocket gopher and lies along the lateral part of the Gastrocnemius, partially covering it.

M. Soleus (Figs. 3, 7, 15)

Origin. The origin is from the caudal surface of the head of the fibula.

Insertion. By tendon which unites with that of the Gastrocnemius and inserts onto the tuberosity of the calcaneus.

Action. Plantar flexes the foot.

Description. This muscle lies proximal to the Gastrocnemius. It is spindal shaped.

M Popliteus (Figs. 3, 5)

Origin. This muscle originates from the lateral epicondyle of the femur.

Insertion. Insertion is upon the proximal three-eighths of the border of the tibia.

Action. Flexes the shank and rotates it medially.

Description. It is a fan-shaped muscle lying beneath the Gastrocnemius. It wraps around the posterior surface of the shank.

M. Flexor digitorum longus (tibialis) (Figs. 5, 9, 17)

Origin. The origin is from the medial ridge of the tibia, close by the insertion of the Popliteus.

Insertion. It inserts by a tendon which passes over the medial malleolus, divides and inserts on the base of the first metatarsal and the other tendon unites with the tendon of the Flexor digitorum fibularis.

Action. Plantar flexes the foot and flexes the terminal phalanges.

Description. A small muscle close to the Popliteus.

M. Flexor digitorum fibularis (Figs. 5, 9, 13)

Origin. It arises from the tibiofibula and interosseous membrane from the proximal two-thirds of the shank.

Insertion. It passes by a large tendon through a groove on the caudal surface of the tibiofibula between the malleoli. It divides on the plantar surface of the foot and inserts on the distal phalanges of the five digits.

Action. Flexes the digits.

Description. This is a large, thick muscle on the posterior surface of the tibiofibula.

M. Tibialis posterior (Figs. 5, 7, 9, 17)

Origin. The origin is deep and caudal from the insertion of the Popliteus, from the caudal fossa of the tibia and from the medial surface of the head

of the fibula and fascia of the Flexor digitorum fibularis.

Insertion. It inserts by a tendon which forms the lower half of the shank. It passes over the medial malleolus of the tibia and inserts on the medial tarsal bone.

Action. Inverts and plantar flexes the foot.

Description. This is a round, thick muscle with a major part of it being tendon.

M. Tibialis anterior (Figs. 3, 7, 11, 13, 15)

Origin. It arises from the lateral condyle and proximal half of the body of the tibia.

Insertion. Insertion is by a tendon onto the first cuneiform and the base of the first metatarsal.

Action. Dorsal flexes the foot.

Description. The muscle is large and broad. It is long, running down the shaft of the tibia.

M. Extensor hallucis longus (Figs. 3, 7)

Origin. This muscle arises from the interosseous fascia between the tibia and fibula.

Insertion. It attaches by a small tendon upon the dorsal aspect of the hallux, upon the terminal phalanx.

Action. Extends the terminal phalanx of the hallux.

Description. This is a very small muscle lying between the tibia and fibula. It passes in close relation with the Tibialis anterior.

M. Extensor digitorum longus (Figs. 3, 7, 11, 15, 17)

Origin. The Extensor digitorum longus originates by a tendon from a depression near the lateral lip of the patellar groove and from the fibular collateral ligament.

Insertion. It inserts by tendons on the terminal phalanges of the four digits with some fascial attachment to each phalanx and to the heads of the metatarsals.

Action. Extends the proximal phalanges and dorsally flexes the foot.

Description. This is a long narrow muscle which lies between the Tibialis anterior and the Peroneus longus.

M. Peroneus longus (Figs. 3, 9, 11, 15, 17)

Origin. It arises from the cranial and lateral surfaces of the head of the fibula.

Insertion. The insertion is by a tendon through a groove of the lateral malleolus, onto the first cuneiform and metatarsal bone.

Action. Everts and plantar flexes the foot.

Description. A long, thin muscle which lies medial to the Extensor digitorum longus.

M. Peroneus brevis (Figs. 3, 9, 11, 15)

Origin. The origin is from the cranial surface of the fibula, interosseous membrane and part of the tibiofibula.

Insertion. A tendon forms the insertion. It passes behind and under the lateral malleolus, over the trochlear process of the calcaneus and inserts on the tuberosity of the fifth metatarsal.

Action. Everts and plantar flexes the foot.

Description. The Peroneus brevis muscle is smaller than the Peroneus longus. It is long and narrow, having a rather round form. It lies medial to the Peroneus longus.

M. Extensor digiti quinti (Peroneus digiti quinti) (Figs. 3, 7)

Origin. The origin is from the proximal fibular shaft.

Insertion. It inserts by a tendon onto the distal end of the fifth metatarsal

and proximal ends of the first and second phalanges.

Action. Extends the digits.

Description. Very small muscle with few muscle fibers.

M. Extensor digiti quarti (Peroneus digiti quarti) (Figs. 3, 7)

Origin. It originates from the proximal shaft of the fibula.

Insertion. Insertion is by a tendon onto the dorsolateral surface of the metatarsal of the fourth digit and all its phalanges

Action. Extends the fourth digit.

Description. Small, long muscle with few muscle fibers. It lies proximal to the Extensor digiti quinti.

Mm. Extensors digitorum brevis (Fig. 7)

Origin. Origin is from the calcaneus for the two muscles in this group.

Insertion. They both insert on the second and third digits.

Action. Extend the second and third digits.

Description. Very short muscles.

M. Flexor digitorum brevis (Fig. 9)

Origin. It originates from the deep surface of the Plantaris tendon.

Insertion. Insertion is by a slender tendon onto the second phalanx of the second digit.

Action. Flexes the proximal phalanx of the second digit.

Description. It is a very small slip of a muscle on the plantar aspect of the foot.

M. Quadratus plantae (Fig. 9)

Origin. Some muscle fibers seem to originate from the medial surface of the calcaneus.

Insertion. It inserts onto the tendon of the Flexor digitorum fibularis.

Action. Helps the Flexor digitorum longus tendons to flex the terminal

phalanges of the digits.

Description. This too is a very small muscle in the pocket gopher with few muscle fibers.

Mm. Lumbricales (Fig. 9)

Origin. Originates from the long flexor tendons.

Insertion. There are two small slips which go to the medial sides of the proximal phalanx of the fourth and fifth digits.

Action. Flexes the proximal phalanx of the fourth and fifth digits.

Description. These are very small muscles, the fifth is the larger.

M. Flexor hallucis brevis (Fig. 9)

Origin. It originates from the plantar surface of the third cuneiform.

Insertion. It attaches at the metatarsophalangeal joint onto the sesamoid bone of the hallux.

Action. Flexes the terminal phalanx of the hallux.

Description. Very small muscle which lies on the plantar surface of the foot.

M. Abductor hallucis (Fig. 9)

Origin. This muscle originates from the plantar surface of the navicular and second cuneiform bones.

Insertion. The attachment for this muscle is on the plantar surface of the proximal phalanx of the hallux. There is a large sesamoid bone present here.

Action. Abducts the proximal phalanx of the hallux.

Description. Like other muscles of the foot, this muscle is very small and short.

M. Abductor digiti minimi (ossis metatarsi quinti) (Fig. 9)

Origin. It arises from the plantar aspect of the calcaneus bone.

Insertion. Insertion is upon the fifth metatarsal bone.

Action. Stabilizes the fifth digit.

Description. This is a stout ligament which runs from the calcaneus to the fifth metatarsal bone on the sole of the foot.

Mm. Interossei (Fig. 9)

Origin. The muscles to the second digit arise from the third cuneiform bone and the base of the second metatarsal. The other muscles arise from the cuboid and bases of their respective metatarsal bones.

Insertion. They attach to the sesamoid bones at the metatarsophalangeal joints.

Action. Abducts and adducts the digits.

Description. There are two muscles to each of the four lateral digits. These are small, running a very short distance.

B. Kangaroo Rat

M. Psoas minor (Figs. 2, 14, 18)

Origin. This muscle arises from the first three lumbar vertebrae.

Insertion. It inserts by a tendon upon the psoas process of the innominate bone.

Action. Flexes the pelvis and lumbar vertebral column.

Description. There is a fleshy origin and a tendinous insertion. This is a long muscle which lies superficial to the Psoas major.

M. Psoas major (Figs. 6, 14, 18)

Origin. It arises from the first five lumbar vertebrae.

Insertion. Insertion is upon the lesser trochanter of the femur, along with that of the Iliacus.

Action. Flexes the femur and rotates it laterally.

Description. This is a well developed muscle lying deep to the Psoas minor.

M. Iliacus (Figs. 2, 6, 14, 18)

Origin. The origin is from the whole of the inferior gluteal fossa of the ilium, to just below the rectus process.

Insertion. This muscle joins with the Psoas major at the insertion on the anterior part of the lesser trochanter.

Action. Flexes the femur and rotates it laterally.

Description. It is a large fan-shaped muscle lying next to the Psoas major. It has a thick, wide origin.

M. Gluteus superficialis (Figs. 2, 4, 12, 14)

Origin. It originates from the dorsal aponeurosis and from the iliac crest.

Insertion. Insertion is upon the proximal part of the lateral ridge of the femur and fascia covering the anterior thigh.

Action. Abducts and laterally rotates the femur.

Description. Very thin and partly formed from an aponeurotic sheet.

M. Gluteus maximus (Fig. 4)

Origin. The origin is from the dorsal fascia above the ilium.

Insertion. The Gluteus maximus inserts upon the posterior border of the greater trochanter and distally to the base of the lateral crest.

Action. Extends, abducts and laterally rotates the femur.

Description. This muscle is very thin and composed of fascia with the muscle fibers. It covers a large area and is superficial to the Gluteus medius.

M. Gluteus medius (Figs. 2, 4)

Origin. It arises slightly from fascia covering the iliocostalis but is mostly from the anterior part of the superior gluteal fossa of the ilium and for a short distance ventrally on the crest.

Insertion. Insertion is upon the greater trochanter, superior to the Vastus lateralis.

Action. Abducts the femur.

Description. It is a very large, thick muscle and is the largest of the Gluteal complex.

M. Gluteus minimus (Figs. 2, 4, 16)

Origin. The Gluteus minimus arises from the entire superior gluteal fossa of the ilium and caudally almost to the acetabulum.

Insertion. This muscle inserts upon the cranial border of the greater trochanter.

Action. Abducts the femur.

Description. It lies ventrad to the Gluteus medius and is a large muscle.

M. Gemellus superior (Figs. 2, 16)

Origin. This muscle originates from the middle of the superior iliac border

as far caudally as the process before the acetabulum.

Insertion. It inserts by a tendon upon the greater trochanter.

Action. Rotates the femur laterally.

Description. This muscle is almost completely fused with the Piriformis. It lies ventral to the Gluteus medius muscle and is fan-shaped.

M. Piriformis (Figs. 4, 16)

Origin. The fibers of this muscle arise from the transverse processes of the third and fourth sacral vertebrae.

Insertion. Insertion is by a tendon upon the greater trochanter.

Action. Rotates the femur laterally.

Description. This muscle was fused with the Gemellus superior muscle to the point of being virtually inseparable. It is distinguishable only from the origin.

M. Obturator internus (Figs. 2, 6)

Origin. It arises from two origins, the posterior portion from the caudal part of the obturator foramen, and the other part from a well defined fossa medial and caudal to the acetabulum.

Insertion. The tendons from the two parts join and insert into the trochanteric fossa.

Action. Rotates the femur laterally and extends it when the femur is flexed.

Description. A relatively small, short muscle, which lies next to the Gemellus inferior.

M. Gemellus inferior (Figs. 2, 6, 16)

Origin. The main part arises from the ischial border, anterior to the notch for the internal obturator tendon, but the muscle had extended slightly to the rear of this point, thus, covering the obturator tendon. These fibers arise from deep sacral fascia.

Insertion. Insertion is upon the obturator tendon which inserts into the trochanteric fossa.

Action. Rotates the femur laterally.

Description. This is a small muscle which lies next to the Quadratus femoris, cranially.

M. Quadratus femoris (Figs. 2, 4, 16)

Origin. Part of the origin is tendinous from the cranial part of the lateral ischial tuberosity and the fleshy origin is from almost all of the ischium posterior to the obturator foramen.

Insertion. The fleshy insertion is upon the proximal base of the third trochanter of the femur. The tendinous insertion is upon the lesser trochanter and its proximal ridge.

Action. Rotates the femur laterally, and powerfully adducts it.

Description. It is a large muscle which appears to be in two portions but is actually indivisible.

M. Obturator externus (Figs. 2, 6, 16)

Origin. This muscle arises from all of the external margin of the obturator foramen except the extreme cranial portion.

Insertion. It inserts into the trochanteric fossa of the femur.

Action. Adducts and rotates the femur laterally.

Description. It is fan-shaped and a large, thick muscle.

M. Semimembranosus (Figs. 2, 6, 14, 16, 18)

This muscle occurs in two divisions with origins and insertions both separate.

A. M. Pars postica

Origin. The Pars postica is the posterior muscle and arises from the ischium along the lateral ridge extending from the tuberosity.

Insertion. The insertion of Pars postica is by fascia upon the distal part of the patellar ligament, which inserts upon the tibial tuberosity.

Action. Flexes the shank.

B. M. Pars anticus

Origin. The Pars anticus arises deep to and anterior to the origin of Pars postica.

Insertion. The insertion of Pars anticus is by two divisions. The larger and more medial inserting upon the medial epicondyle of the femur. The second slip inserts upon the base of the femoral shaft, adjacent, but more toward the lateral side.

Action. Flexes the shank and extends the femur.

Description. There are two definite muscles here. The postica is the larger of the two. They are both long and ribbon-like, and wide.

M. Semitendinosus (Figs. 2, 6, 12, 14)

Origin. This muscle arises from two heads. The origin of the fascial head is from the dorsum and the ischial head is from the ischial tuberosity.

Insertion. The two heads fuse shortly and there occurs a completely transverse aponeurotic inscription. From this the main portion of the muscle inserts on the middle of the calf, but a small slip diverges to fuse with the Biceps femoris posticus and pass to the lateral thigh.

Action. Powerfully extends the femur and flexes the shank.

Description. This muscle is very long and thick. It passes from the dorsal surface to the ventral. It is wider at the insertion.

M. Biceps femoris anticus (Figs. 4, 12)

Origin. The Biceps femoris anticus arises from the dorsal aponeurosis over the ischium.

Insertion. Insertion is upon the patellar ligament which inserts on the

tibia.

Action. Flexes the leg.

Description. It is a long,stout muscle which is thick and partly fused with the Biceps femoris posticus.

M. Biceps femoris posticus (Figs. 2, 4, 12)

Origin. The origin is by an aponeurosis from the ischial tuberosity.

Insertion. This muscle has a very wide insertion over the shank.

Action. Flexes the femur.

Description. This is a thin sheet of muscle which runs very close to the anticus and is partially fused with it.

M. Tenuissimus

Origin. The Tenuissimus arises from the deep dorsal fascia, deep to the anterior biceps.

Insertion. It inserts by fascia upon the medial calf.

Action. Flexes the shank.

Description. This is a long, extremely small muscle.

M. Rectus femoris (Figs. 2, 4, 14)

Origin. It originates from the rectus femoris process of the ilium.

Insertion. Insertion is on the proximal patella.

Action. Flexes the femur and extends the shank.

Description. Very large massive muscle. It lies dorsad to the Vastus intermedius and is covered laterally by the Vastus lateralis.

M. Vastus lateralis (Figs. 4, 12, 14, 16, 18)

Origin. This muscle arises from the distal border of the greater trochanter.

Insertion. The insertion is upon the patella and its tendon to the tibia.

Action. Extends the shank.

Description. This is a large, well developed muscle. It lies dorsal to

the Rectus femoris but does not cover it at its origin.

M. Vastus medialis (Figs. 14, 18)

Origin. The Vastus medialis arises from the anterior surface of the lesser trochanter and the adjoining shaft. It passes dorsal to the head onto the greater trochanter and its caudal border.

Insertion. Fibers from the posterior part insert upon an aponeurosis that covers most of the Vastus intermedius. The main insertion is medially upon the patella.

Action. Extends the shank.

Description. This muscle is also large and is larger at the origin than at the insertion. It runs adjacent to the Rectus femoris, caudally, and covers some of the Rectus femoris on the edge.

M. Vastus intermedius (Fig. 6)

Origin. It originates from the anterior shaft--both medially and laterally.

Insertion. Insertion is onto the capsule of the knee joint.

Action. Extends the shank.

Description. The fibers are very close to those of the Vastus lateralis. It runs next to the shaft of the femur and is very thin.

M. Pectineus (Figs. 2, 6, 14, 18)

Origin. The origin is a short distance along the ventral pubic border, immediately caudal to the psoas process.

Insertion. It inserts by a tendon along the proximal part of the femoral shaft.

Action. Adducts the femur and flexes it.

Description. It is a small triangular shaped muscle, thick and ending in a tendon. It lies craniad of the Adductor longus accessorius.

M. Gracilis (Figs. 2, 6, 14)

A. M. Pars postica

Origin. The posterior division originates along the caudoventral border of the ischium as far as the anterior part of the symphysis.

Insertion. Insertion is along the shank, over an area proximal to the Semitendinosus, almost as far as the patellar ligament.

B. M. Pars anticus

Origin. The anterior part originates along the ventral margin of the pubis, cranial to the posterior portion.

Insertion. It inserts upon the patellar ligament, cranial to the Semimembranosus posticus.

Action. They both adduct the femur and possibly flex the shank.

Description. They are both very much alike, being very thin, narrow and long. The Gracilis anticus lies craniad to the Gracilis postica.

M. Adductor longus accessorius (Figs. 2, 6, 14, 18)

Origin. This muscle originates from along the pubic border, caudal to the Pectineus.

Insertion. It inserts by a tendon which joins the distal part of the pectineal tendon to insert upon the femur.

Action. Adducts the femur.

Description. This muscle resembles, from the superficial aspect, the Adductor longus of man. It is triangular shaped and thick.

M. Adductor brevis (Figs. 2, 16)

Origin. It has a thin origin from the ventral ischial border between the Adductores longus accessorius and magnus.

Insertion. It inserts upon the caudal surface of the third trochanter.

Action. Adducts the femur.

Description. This is a long muscle which lies deep to the Adductor magnus.

M. Adductor magnus (Figs. 2, 4, 16)

Origin. The Adductor magnus arises from the caudoventral part of the ischial border.

Insertion. It inserts upon the femoral shaft distal to the third trochanter for about three-fifths of the distance to the condyles.

Action. Adducts the femur.

Description. This muscle is wide, large and lies dorsal to the Adductor longus primus.

M. Adductor longus primus (Figs. 2, 4, 14, 16, 18)

This muscle may be the counterpart of the Adductor minimus in the pocket gopher.

Origin. It originates along the pubic border, from the Adductor brevis to the Pectineus and deep to the longus accessorius.

Insertion. The insertion is along almost the entire shaft of the femur.

Action. Adducts the femur.

Description. This is the main longus muscle which is more like that in man. It is long narrow and thick.

M. Gastrocnemius (Figs. 4, 6, 8, 12, 14, 16, 18)

Origin. This muscle is divided into two portions. The lateralis originates from the lateral epicondyle of the femur and the lateral sesamoid bone. At the center of the superficial belly the origin was tendinous which diverges to form a small aponeurotic sheet. The medialis portion originates from the medial epicondyle of the femur and the medial sesamoid bone. It extends a short distance proximally along the shaft of the femur. The aponeurosis is more extensive than in the lateralis.

Insertion. They have a common insertion by a tendon to the lateral side of the calcaneus.

Action. Plantar flexes the foot and flexes the leg.

Description. Both portions are very stout muscles which form the bulk of the lower leg.

M. Plantaris (Figs. 4, 10, 12, 16)

Origin. This muscle has origin by a tendon from the lateral sesamoid, hardly separable from those of the Gastrocnemius lateralis. Its aponeurosis is fairly continuous with that of the Gastrocnemius.

Insertion. The muscle inserts by a tendon over the heel and sole where it splits into four tendons. Three pass to the three medial digits and attach to the base of the second phalanx. The tendon to the fifth toe passes to the lateral side of the digit.

Action. Flexes the shank and plantar flexes the foot.

Description. The Plantaris is very continuous with the Gastrocnemius lateralis and partially hidden by it. It is a stout muscle.

M. Soleus (Figs. 4, 8, 16, 18)

Origin. The Soleus arises by a tendon from the fibular head.

Insertion. It inserts by a tendon which is fused with approximately one-half of the common gastrocnemial tendon.

Action. Plantar flexes the foot.

Description. It is a long, narrow muscle hidden by the Gastrocnemius.

M. Popliteus (Figs. 4, 6)

Origin. It originates by a tendon from the lateral epicondyle of the femur.

Insertion. Insertion is upon the border of the popliteal fossa.

Action. Flexes the shank and rotates it medially.

Description. This is a fan-shaped muscle which wraps around the back of the tibia.

M. Flexor digitorum longus (Flexor tibialis) (Figs. 6, 14, 18)

Origin. The origin is by a tendon from the medial tibial border distal to the Popliteus insertion.

Insertion. The insertion is by a tendon which passes behind a groove on the medial malleolus and fuses with the Flexor digitorum fibularis tendon.

Action. Plantar flexes the foot and flexes the terminal phalanges.

Description. This is a very slender, long muscle.

M. Flexor digitorum fibularis (Figs. 4, 6, 10, 12, 14, 18)

Origin. It arises from the fibular head, medial to the Soleus,and distally along the shaft, from the interosseous membrane, and from the medial aspect of the posterior shaft of the tibia.

Insertion. It inserts by a tendon which passes over the medial malleolus to the sole, deep to the Plantaris. At the middle of the sole it splits into four heavy tendons which insert upon the terminal phalanges of all the digits.

Action. Flexes the digits.

Description. This is a large flat muscle, running down the whole of the lower leg, posteriorally.

M. Tibialis posterior (Figs. 6, 10)

Origin. The origin is the fibular head, posteromedial tibial border and the interosseous membrane, deep to the Popliteus.

Insertion. The insertion is by a tendon which passes to the medial tarsal sesamoid where it attaches.

Action. Plantar flexes and inverts the foot.

Description. This is a very small muscle with the muscle fibers ending shortly in a tendon for insertion.

M. Tibialis anterior (Figs. 4, 8, 12, 14, 16, 18)

Origin. It originates from the entire tibial fossa deep upon the lateral aspect of the bone.

Insertion. It attaches by a tendon which passes beneath the transverse ligament of the ankle and then to the medial ankle to insert upon the middle of metatarsus one.

Action. Dorsally flexes the foot.

Description. This is a well developed muscle. It is large and covers the anterior part of the lower leg partially. It lies next to the Extensor digitorum longus.

M. Extensor hallucis longus (Figs. 4, 8)

Origin. It arises from the crural interosseous membrane.

Insertion. Insertion is by a tendon which passes beneath the transverse ligament and then diverges with, but cranial to, the Tibialis anterior to the medial side of the foot. It passes to the medial side of the second digit and attaches to the proximal phalanx of the second toe.

Action. Extends the proximal phalanx of the second toe.

Description. This muscle lies deep to the Tibialis anterior and is relatively small muscle.

M. Extensor digitorum longus (Figs. 4, 8)

Origin. The origin is by a tendon from the lateral epicondyle of the femur, near the patellar ligament.

Insertion. It inserts by a tendon which splits into four branches which pass beneath the transverse ligament in company with the Tibialis anterior and Extensor hallucis longus and extends to the four digits. These branches are superficial to other tendons. The main tendons join the toes upon the lateral side of digit 2, center of 3 and medial side of digits 4 and 5.

The tendon that passes to the second digit gives off a smaller lateral branch and that of digit four a medial branch, both attach to the sides of digit three.

Action. Extends the proximal phalanges of the four digits and dorsally flexes the foot.

Description. This is a long, thick, narrow muscle. It is rounded and is partially hidden by the Tibialis anterior which lies by it.

M. Peroneus longus (Figs. 4, 10, 12, 16)

Origin. The origin is from the fibular head in connection with the collateral ligament.

Insertion. Its tendon passes behind the lateral malleolus and inserts upon the plantar process of metatarsus one.

Action. Plantar flexes and everts the foot.

Description. This is a very long, narrow, rounded muscle lying medial to the Extensor digitorum longus.

M. Peroneus brevis (Figs. 4, 10, 12, 16)

Origin. It arises from the medial border of the fibula for its entire length and continuing onto the tibia at the junction of the two bones.

Insertion. The insertion is upon the base of metatarsus five.

Action. Everts and plantar flexes the foot.

Description. The Peroneus brevis is a very long, rounded, narrow muscle, deep to the Peroneus longus.

M. Extensor digiti quinti (Peroneus digiti quinti) (Figs. 4, 8)

Origin. The origin is from the proximal fibular shaft.

Insertion. It attaches to the lateral side of the fifth digit at the terminal phalanx.

Action. Extends the fifth digit.

Description. It is a long muscle, deep to the Peroneus brevis and Peroneus longus. It is wide at its insertion.

M. Extensor digiti quarti (Peroneus digiti quarti) (Figs. 8)

Origin. It arises from the caudolateral belly of Extensor digiti quinti.

Insertion. It attaches to the second phalanx by a tendon.

Action. Extends the second digit.

Description. The above muscle has very few muscle fibers. It runs adjacent to Extensor digiti quinti.

M. Quadratus plantae

Origin. The origin is from the deep surface of the Plantaris tendon.

Insertion. The tendon is fused with that of the Plantaris and attaches with it.

Action. Plantar flexes the foot.

Description. There are very few muscle fibers present and is very hard to distinguish.

Mm. Interosseous (Fig. 10)

Origin. There are two of these muscles. The origin is by an aponeurosis from the plantar process of the navicular bone.

Insertion. One attaches to the inner side of the second digit and the other attaches to both sides of the fourth digit.

Action. Adducts the second digit, and adducts and abducts the fourth digit.

Description. Very few muscle fibers on the plantar aspect of the foot.

Mm. Lumbricales (Fig. 10)

Origin. There are three of these muscles and they arise from the Flexor digitorum fibularis tendons.

Insertion. They insert upon the proximal phalanx on the medial sides of the third, fourth and fifth digits.

Action. Flexes the proximal phalanx of the third, fourth, and fifth digits.

Description. They are very small in the three intervals between the Flexor digitorum fibularis tendons.

Mm. Flexors digitorum breves (Fig. 10)

Origin. The flexor to digit two arises by a short tendon from the navicular bone and a fleshy origin arises from the end of the first metatarsal. The flexor to digit three arises from the cuboid, and those to four and five arise from the lateral sesamoid bone.

Insertion. The insertion is upon both sides of each digit.

Action. Flexes all four digits.

Description. These are the short flexors to each toe. There are very few muscle fibers present.

M. Abductor digiti minimi (Abductor ossis metatarsi quinti) (Figs. 8, 10)

Origin. It arises from the calcaneus tendon.

Insertion. Insertion is upon the lateral process of metatarsal five.

Action. Abducts the fifth digit.

Description. This muscle is largely tendinous with very few muscle fibers and the origin is difficult to ascertain.

ANALYSIS OF MEASUREMENTS

Foster (1896) has shown that a muscle with the greater bulk will do the most work. He states:

> If two muscles are unequal both in length and sectional area, the work done will be greater in the one which has the greater bulk, which contains the greater number of cubic units. In speaking, therefore, of the work which can be done by a muscle, we may use as a standard a cubic unit of bulk, or, the specific gravity of the muscle being the same, the unit of weight.

Thus, volume is selected as an indicator of strength. This method seems better adapted for testing both muscles and bones (Holliger, 1916).

The volumetric measurements were taken of the larger muscles and of muscle groups for comparison purposes. Special note was taken of those muscles or groups of muscles which are used more in the jumping movements.

It was found, as listed in table 1, that for all the muscles measured, except one, the volume percent in relation to the total body volume was greater in Dipodomys. The Quadriceps femoris, which act together to extend the shank (the Rectus femoris of this group flexes the thigh) in Thomomys comprised 2.08 % of the total body volume as compared to 2.94 % for Dipodomys. The Semimembranosus, Semitendinosus, and Biceps femoris of Thomomys were 2.60 % of the body volume as compared to 5.88 % for Dipodomys. The action of these muscles is to flex the shank and the Semitendinosus extends the thigh also.

Greater variations can be found in the lower leg. Here the Gastrocnemius and the Plantaris comprised 1.04 % in Thomomys and 2.94 % in Dipodomys. Thus, the percentage for Dipodomys is double that of Thomomys.

TABLE 1

VOLUMETRIC MEASUREMENTS OF CERTAIN MUSCLES OF THE HIND LIMB OF THOMOMYS UMBRINUS AND DIPODOMYS ORDII

Muscle or Muscle Group Measured	Volumetric Displacement		Volume Percentage of Total Body Volume*	
	Thomomys umbrinus	Dipodomys ordii	Thomomys umbrinus	Dipodomys ordii
Semimembranosus	0.35 ml	0.40 ml.	0.73 %	1.31 %
Semitendinosus	0.20	0.40	0.42	1.31
Biceps femoris	0.70	1.00	1.46	3.27
Quadriceps femoris	1.00	0.90	2.08	2.94
Gracilis	0.09	0.20	0.19	0.65
Adductor magnus and brevis	0.70	0.30	1.46	0.98
Gastrocnemius and Plantaris	0.50	0.90	1.04	2.94
Gluteus maximus	0.20	0.15	0.42	0.49
Gluteus medius	0.40	0.50	0.83	1.63
Entire lower leg plus bones and foot	1.20	2.50	2.50	8.17

*Total Body Volume of Thomomys umbrinus--Skinned, Eviscerated and Beheaded = 48.0 ml.

*Total Body Volume of Dipodomys ordii--Skinned, Eviscerated and Beheaded = 30.6 ml.

These two muscles, with the Soleus, are the principle muscles involved in plantar flexion of the foot and flexion of the shank. These actions are those used in the strong leaping movements of the kangaroo rat. The volumetric displacement of the whole lower leg was significant here. The percentage of the total body volume of Thomomys was 2.50 as compared to 8.17 in Dipodomys.

When considering the foregoing data, using muscle volume as a criterion of strength, it is evident that the muscles of the hind limb of Dipodomys have greater force of movement than do those of Thomomys.

The muscles having to do with extension of the lower leg at the knee and plantar flexion are those most used in jumping and it is this group of muscles which show the greatest variation between the two animals. Some of the thigh and hip muscles showed less variation and the Adductores magnus and brevis were larger in Thomomys umbrinus. The action of these muscles is to adduct the femur and in the pocket gopher they are needed for stabilization of the hind limb during digging movements. These variations are shown in table 1.

The variations in the lengths and widths of many of the muscles and bones can also be noted from tables 2 and 3. The greater variations in these linear measurements occur in the same muscles as those that varied in volumetric displacement.

The bone measurements of Dipodomys are longer than Thomomys. When these measurements are considered in the light of the total body length they are significant. The length of a typical adult female of Thomomys, from the base of the skull to the base of the tail, is 9.8 cm as compared to 8.2 cm for Dipodomys. The femur in Dipodomys is .4 cm longer than that in Thomomys, a 16.6 % increase. Whereas, the tibiofibula is 1.05 cm longer,

TABLE 2

LINEAR MEASUREMENTS OF THE MUSCLES OF THE HIND LIMB OF THOMOMYS UMBRINUS AND DIPODOMYS ORDII

Muscle	Length		Width	
	Thomomys umbrinus	Dipodomys ordii	Thomomys umbrinus	Dipodomys ordii
Psoas minor	2.85 cm	3.00	0.40	0.30
Psoas major	3.00	2.80	0.52	0.40
Iliacus	1.99	1.70	0.50	0.70
Gluteus medius	1.65	2.00	1.20	1.10
Quadratus femoris	0.80	1.60	0.25	1.00
Semitendinosus	3.10	3.47	0.70	0.80
Biceps femoris a.	2.55	3.60	0.30	1.00
Biceps femoris p.	2.24	2.90	1.00	1.10
Rectus femoris	2.05	2.40	0.70	0.60
Vastus lateralis	2.05	2.60	0.90	1.10
Vastus medialis	1.80	2.25	0.50	0.50
Pectineus	1.30	1.50	0.30	0.35
Adductor longus	1.31	1.60	0.20	0.40
Adductor brevis	1.95	1.60	0.60	0.50
Adductor magnus	2.10	2.30	0.60	0.60
*Gastrocnemius				
lateralis	2.60	3.80	0.50	0.90
medialis	2.60	3.80	0.60	0.92
*Plantaris	2.90	3.70	0.40	0.40
*Soleus	2.00	3.30	0.20	0.30
Popliteus	0.90	0.70	0.20	0.50
*Flexor dig. longus	2.40	2.80	0.30	0.40
*Tibialis anterior	2.30	3.60	0.40	0.60
*Ext. dig. longus	3.00	4.00	0.15	0.30
*Peroneus longus	2.20	3.00	0.10	0.10
*Peroneus brevis	2.20	3.35	--	0.20

*To ankle.

Total Body Length of Thomomys umbrinus = 9.8 cm.
(from base of skull to base of tail)

Total Body Length of Dipodomys ordii = 8.2 cm.
(from base of skull to base of tail)

TABLE 3

LINEAR MEASUREMENTS OF THE BONES OF THE HIND LIMB OF THOMOMYS UMBRINUS AND DIPODOMYS ORDII

Bones	Length		Width	
	Thomomys umbrinus	Dipodomys ordii	Thomomys umbrinus	Dipodomys ordii
Pelvic girdle	3.00 cm	3.00 cm	--	--
at ilium	--	--	1.30	1.80
Obturator foramen	0.70	0.89	0.30	0.40
Acet. to Acet.	--	--	1.31	1.50
Acetabulum	--	--	0.30	0.30
Acet. to ilium				
craniad	1.60	1.50	--	--
caudad	1.20	1.25	--	--
Femur	2.40	2.80	--	--
Epicondyles of femur	--	--	0.60	0.50
Across lesser troch.	--	--	0.60	0.50
Across greater troch.	--	--	0.65	0.58
Tibiofibula	2.55	3.60	--	--
Fibula	1.40	1.90	--	--
Head of Tibia	--	--	0.60	0.50
Calcaneus to end of longest phalanx	2.73	3.50	--	--
Talus	--	--	0.30	0.30
Metatarsal (longest)	0.90	1.59	--	--

Total Body Length of Thomomys umbrinus = 9.8 cm
(from base of skull to base of tail)

Total Body Length of Dipodomys ordii = 8.2 cm
(from base of skull to base of tail)

a 41.15 % increase. Also, the difference in length of the foot is .77 cm, with Dipodomys being 3.50 cm and Thomomys 2.73 cm, this is a 24.54 % increase. The length here is gained extensively in the metatarsals and phalanges. The longest metatarsal in Dipodomys is 1.59 cm as compared to that of .9 cm in Thomomys, a difference of .69 cm, or a 43.39 % increase. Thus, of the total length of the hind limb the tibiofibula is the longer, with the foot next and the femur last. All the bones in the hind limb of Dipodomys are longer despite the shorter body length.

The innominate bone is approximately the same length in both animals. However, the width of the bones in the pelvic girdle and hind limb of Thomomys is greater. They are short and stout, thus facilitating short, strong movements. In Dipodomys the trochanteric fossa extends further to the lesser trochanter, thus increasing the strength of movement of the femur to the rear during leaping because of better leverage.

As would be expected the muscles having to do with leaping movements are those involved in plantar flexion of the foot and extension of the leg. These in Dipodomys are larger, as shown in table 2. Also, the muscles needed for fixation of the limb during extension or flexion are larger in Dipodomys; such as the Pectineus and Adductores, as shown in table 2. The Quadratus femoris exhibits a great difference in the two animals, being twice as long and four times as wide in Dipodomys as in Thomomys. The action of this muscle is rotation of the thigh laterally and as a powerful adductor of the femur. This latter action seems to be as a stabilizer of the femur. It is logical, mechanically, that the action of this muscle is important to stabilize rather than in the action of adduction as such.

The size of the muscles alone does not account for the greater

strength in the hind limb of Dipodomys. Using the principle of levers (White, 1963) the longer bones of Dipodomys would give greater leverage to muscles of this animal.

DISCUSSION

This comparative study of the hind limb of Thomomys umbrinus and Dipodomys ordii was undertaken to determine the morphological differences as they are associated with the habits of the two animals. The anatomical variations seen seem to be adaptive.

The general outline of the bones of the hind limb of Thomomys is regular and the processes are regular and smooth. The spines of the lumbar vertebrae are short and stout, and those from the sacrum are fused. However, the processes are prominent on all the bones. In Dipodomys the bones are very irregular and the processes large. The spines of the vertebrae are long and prominent. This increases the overall area of the bones and allows more space for the attachment of the larger muscles. The femur of Dipodomys has a third trochanter which the pocket gopher does not have.

The muscles in the two animals are very different as to relative size, position and number, and there are different divisions of the same muscles. The Gracilis muscle in the kangaroo rat is divided into two portions, which gives this animal greater stabilization of the longer limb. The Semimembranosus is also divided in Dipodomys and is single in Thomomys. The action of this muscle in both animals is to flex the shank. However, the action of the anterior portion in Dipodomys is to extend the femur, also, thus giving this animal greater extension, as is needed in jumping. The greater size of the Quadratus femoris in the kangaroo rat gives this

animal much greater stabilization of the hind limb. The other stabilizers are more nearly the same size in both animals. However, the kangaroo rat needs greater fixation due to its longer limbs and jumping movements.

Not all of the muscles are present in both animals. The pocket gopher has the Caudofemoralis, Adductor magnus proprius, Adductor minimus and Abductor hallucis, which have no counterpart in the kangaroo rat. The kangaroo rat has the Gluteus superficialis, Tenuissimus and Adductor longus primus, which are not found in the pocket gopher. These variations do not seem to make any significant differences in the overall actions of the muscles. Variations can also be found in the origins and insertions of some of the muscles.

The main muscles involved in plantar flexion of the foot and flexion of the shank are the Gastrocnemius, Plantaris and Soleus. This is the action needed for leaping movements. From the measurements of these muscles this action is strong in the kangaroo rat, as would be expected. In the pocket gopher the different size of the muscles is correlated with its particular habits.

Both species are fossorial, however, the kangaroo rat is highly cursorial. The result is that both animals burrow for different reasons. The kangaroo rat acquires all of its food above ground, at night. It carries seeds in its cheek pouches to the burrow where the seeds are stored for later use. It burrow is used as a place of refuge from predators and to reduce water loss during the day. It usually burrows approximately six inches underground. When above ground, gathering food, it must be quick in its movements. The kangaroo rat is the chief food for many other animals, for this reason it must be swift in order to survive (Fitch, 1948). As a result, the hind limb is highly developed for leaping. The kangaroo rat can leap as

far as 28 inches and this is its mode of locomotion. The longer himd limb also aids him in reaching the seeds on the plants, which it uses for food (Tappe, 1941). This animal has speed and endurance. Thus, the adaptation of the hind limb is for survival purposes.

The pocket gopher lives mainly underground, seldom leaving its burrow, which may be deep with many passages. The gathering of food is underground. The pocket gopher eats the roots of alfalfa and other such plants. Thus, the hind limb is not adapted for leaping as in the kangaroo rat (Scheffer, 1931). The muscles of the hind limb are shorter and stout, giving strength to stabilize the animal while digging underground passage-ways with his forelimbs.

In conclusion, I feel that the morphological differences found in the hind limb of Dipodomys ordii and Thomomys umbrinus are a result of adaptation for survival. Even though they are both fossorial, the kangaroo rat is highly cursorial, thus, their habits are vastly different, resulting in the above adaptations.

SUMMARY

The purpose of this study was to compare the morphology of the hind limb of the pocket gopher with that of the kangaroo rat and to determine their differences. This was accomplished by first, obtaining the specimens; second, preparation of the specimens for preservation and dissection; third, photographing and tracing the muscles; fourth, noting the origin and insertion of each muscle and their general morphology; and fifth, preparation and photographing of the bones.

Comparative volumetric measurements were made of the muscles of the two animals to determine the differences between them. These measurements showed the shank of the kangaroo rat to be twice the size of that of the pocket gopher. The muscles used by the kangaroo rat in jumping are longer and larger as indicated by the volumetric displacement and linear measurements. Also, linear measurements were made of the various muscles and bones. These measurements also showed the variation in length and width, with those muscles of the kangaroo rat being longer and wider. In the study of the bones, the general outlines of the two forms were vastly different. The location of tuberosities, size of these tuberosities for muscle attachment, bone length and width made up these differences.

Origins, insertions, actions and descriptions of the muscles are determined for each animal.

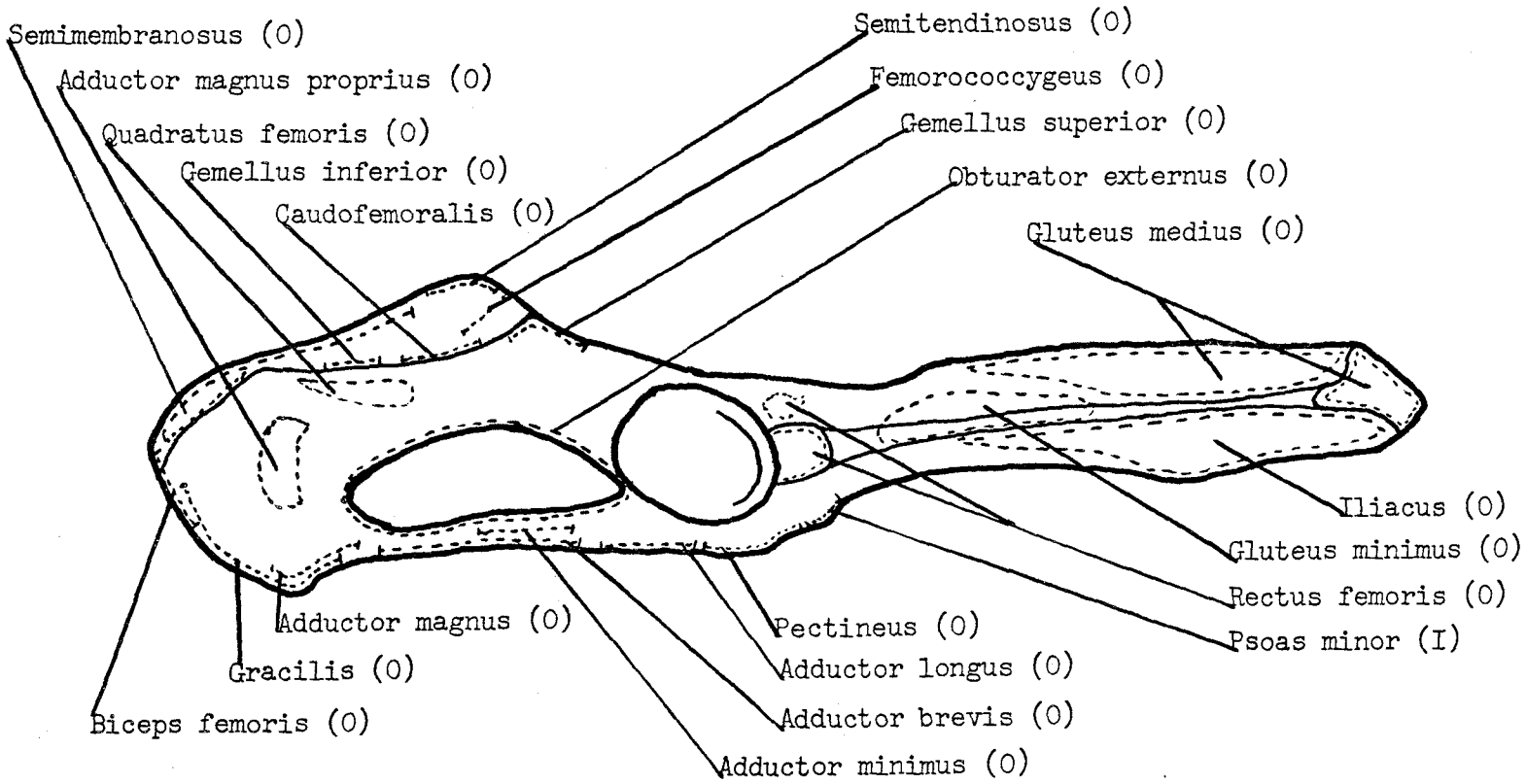

FIG. 1. LATERAL VIEW OF THE PELVIC GIRDLE SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Thomomys umbrinus)

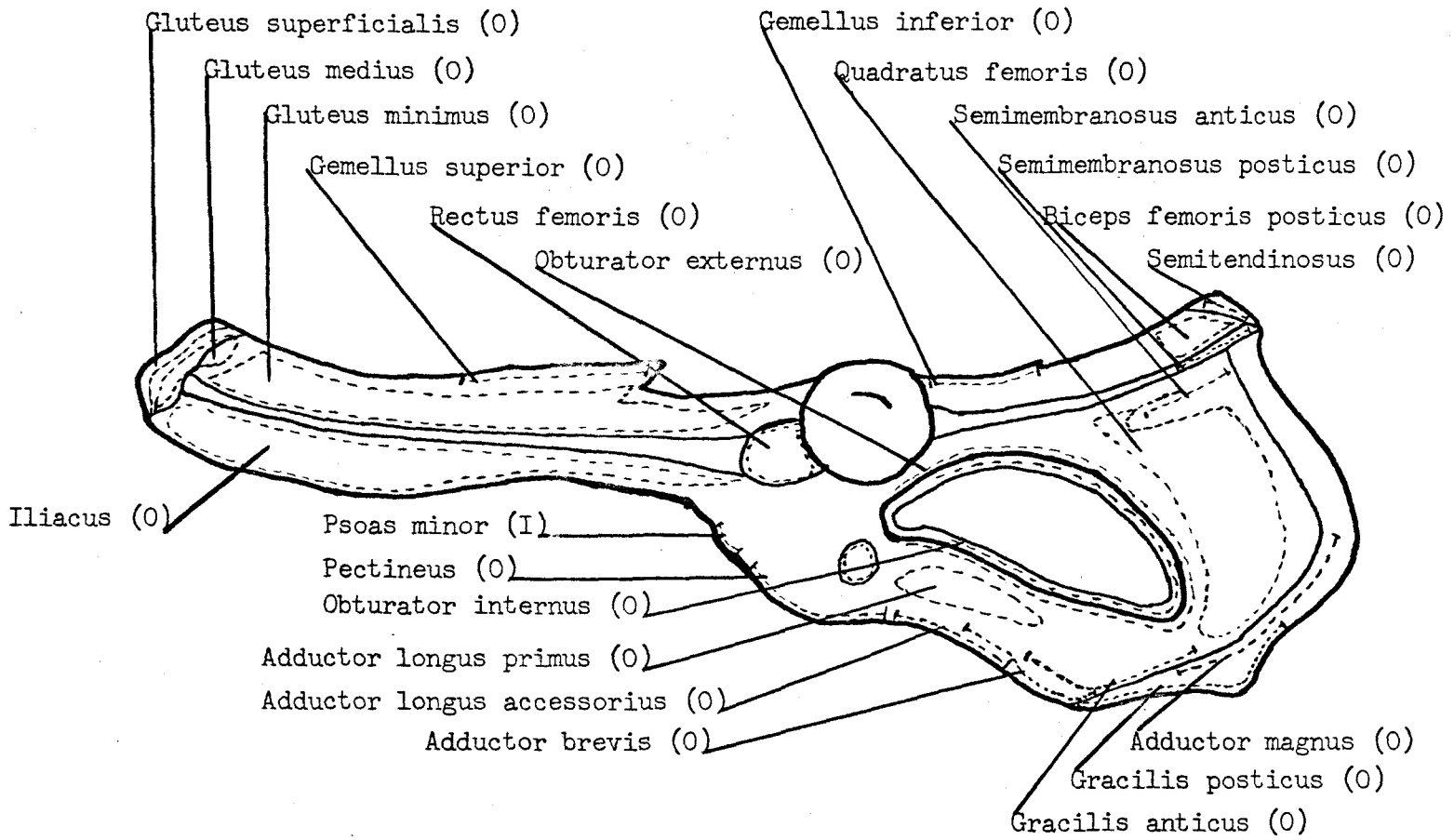

FIG. 2. LATERAL VIEW OF THE PELVIC GIRDLE SHOWING MUSCLE ORIGINS (0) AND INSERTIONS (I)

(Dipodomys ordii)

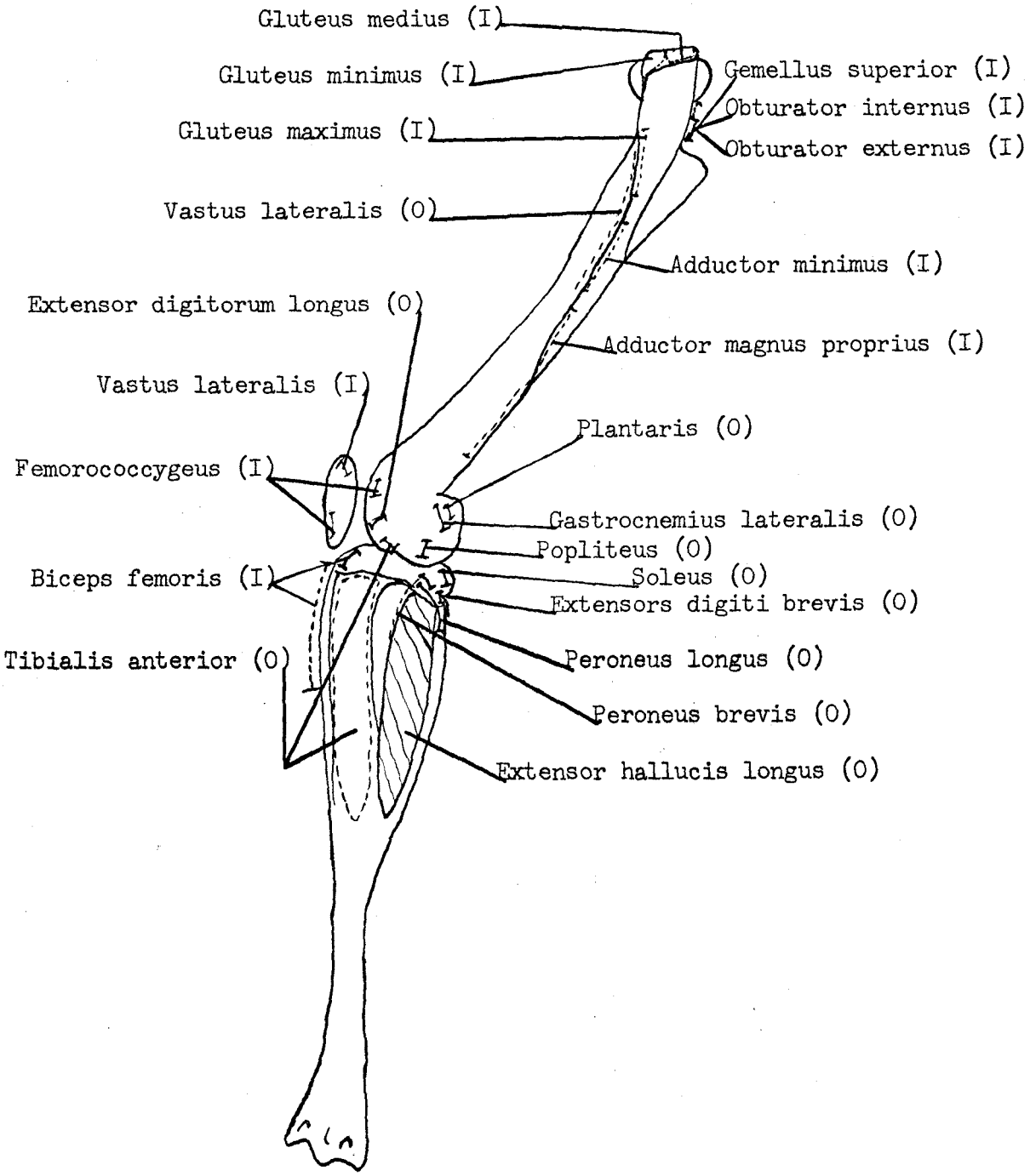

FIG. 3. LATERAL VIEW OF THE BONES OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Thomomys umbrinus)

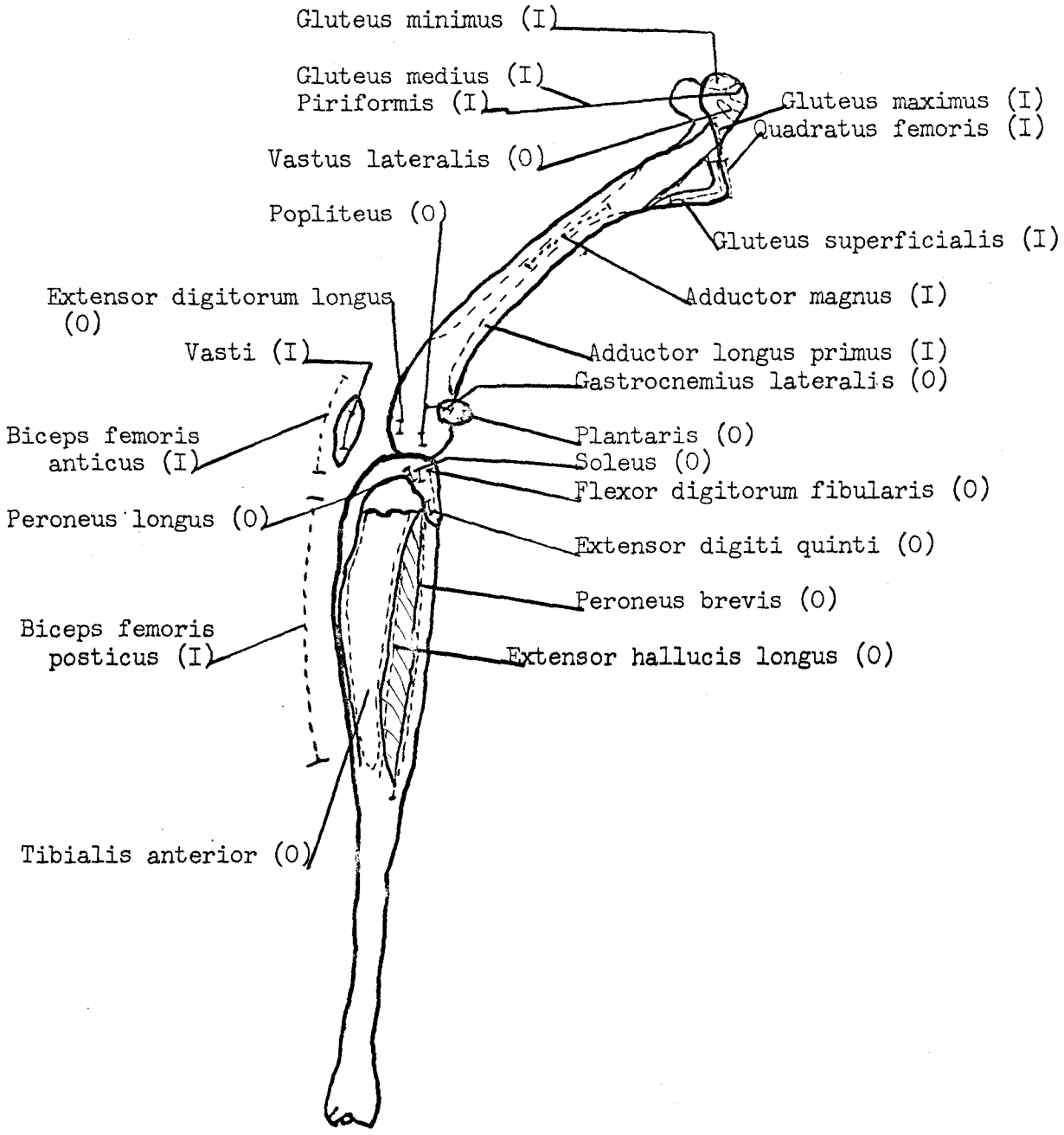

FIG. 4. LATERAL VIEW OF THE BONES OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Dipodomys ordii)

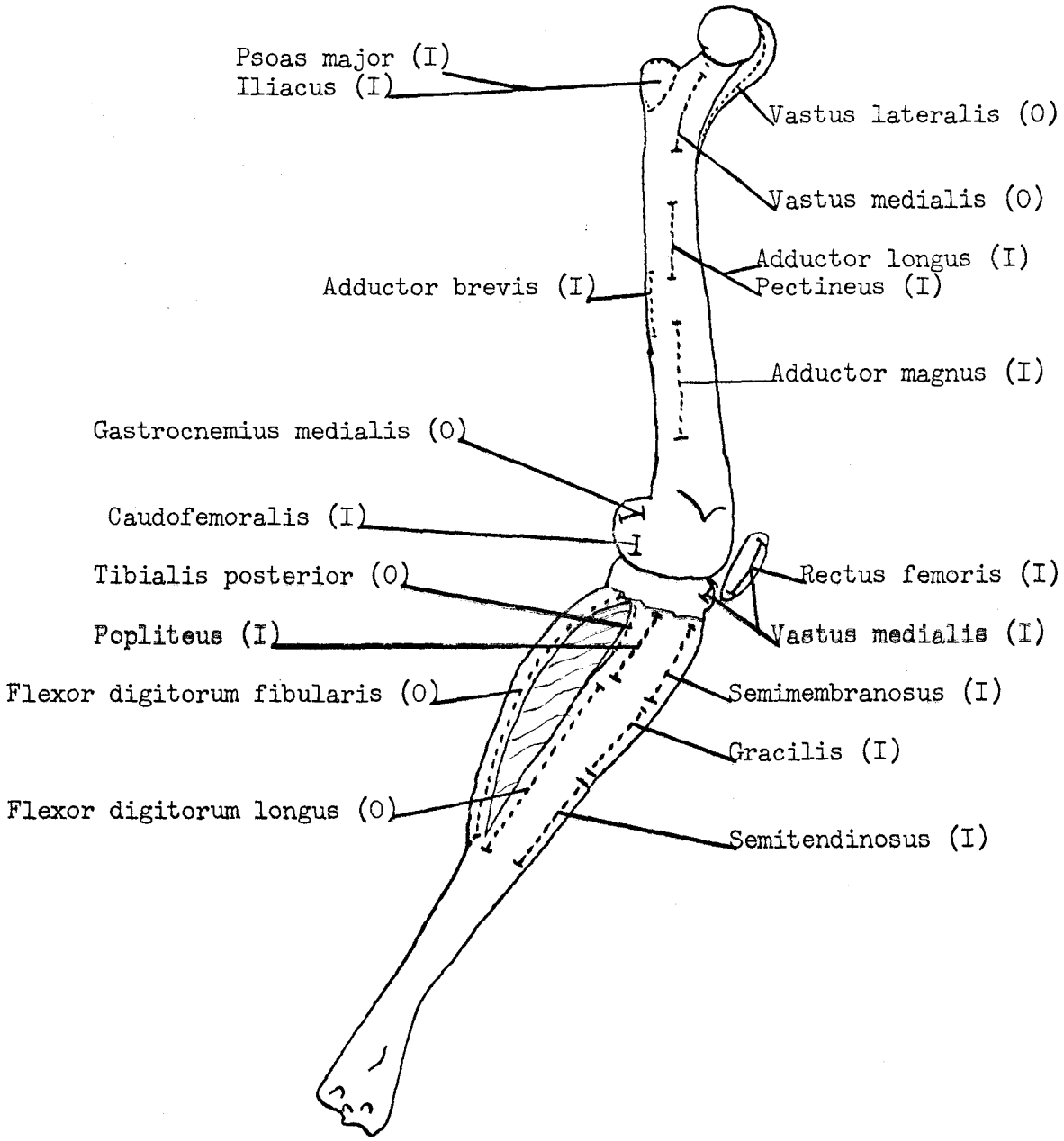

FIG. 5. MESIAL VIEW OF THE BONES OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Thomomys umbrinus)

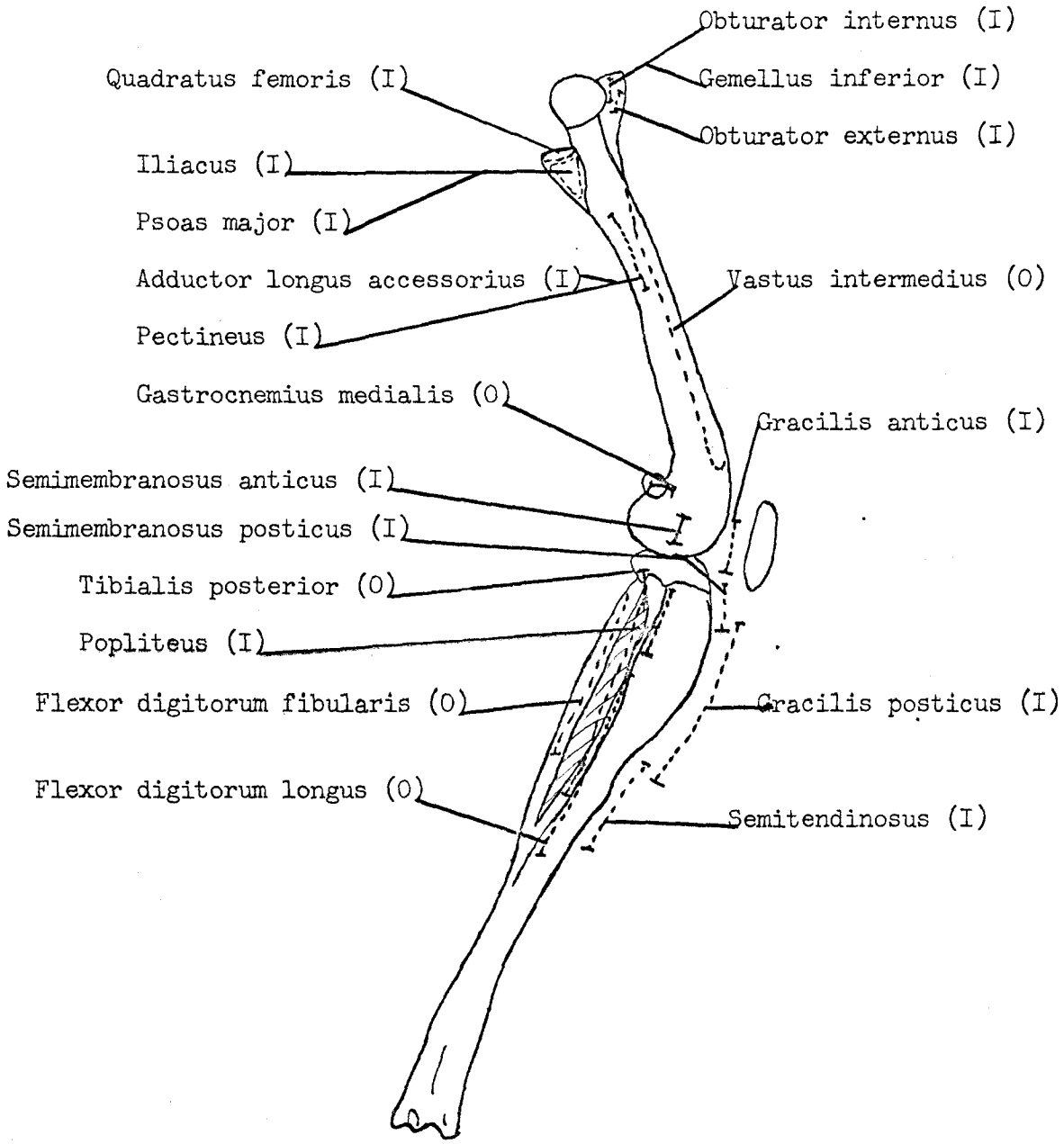

FIG. 6. MESIAL VIEW OF THE BONES OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Dipodomys ordii)

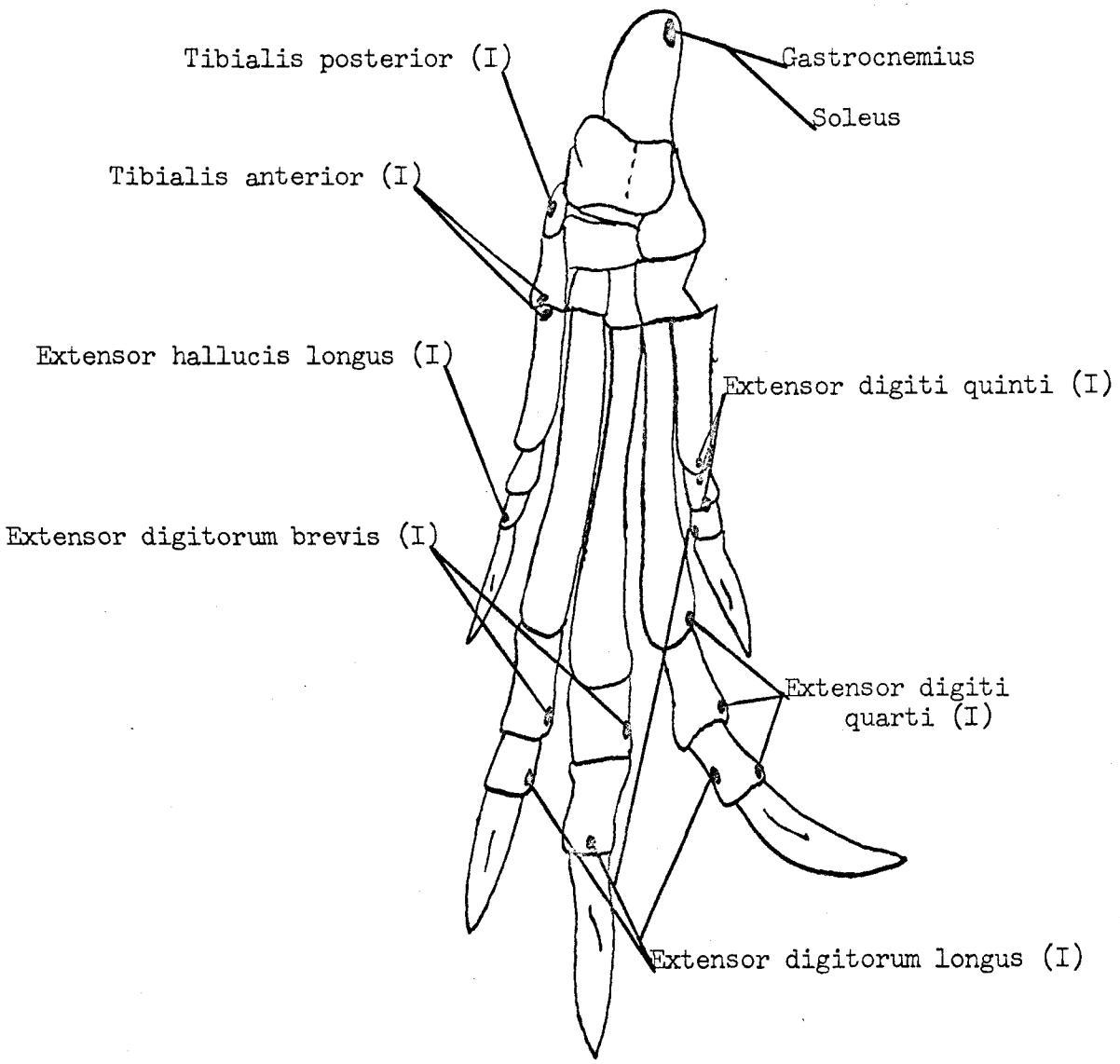

FIG. 7. DORSAL VIEW OF THE BONES OF THE FOOT OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Thomomys umbrinus)

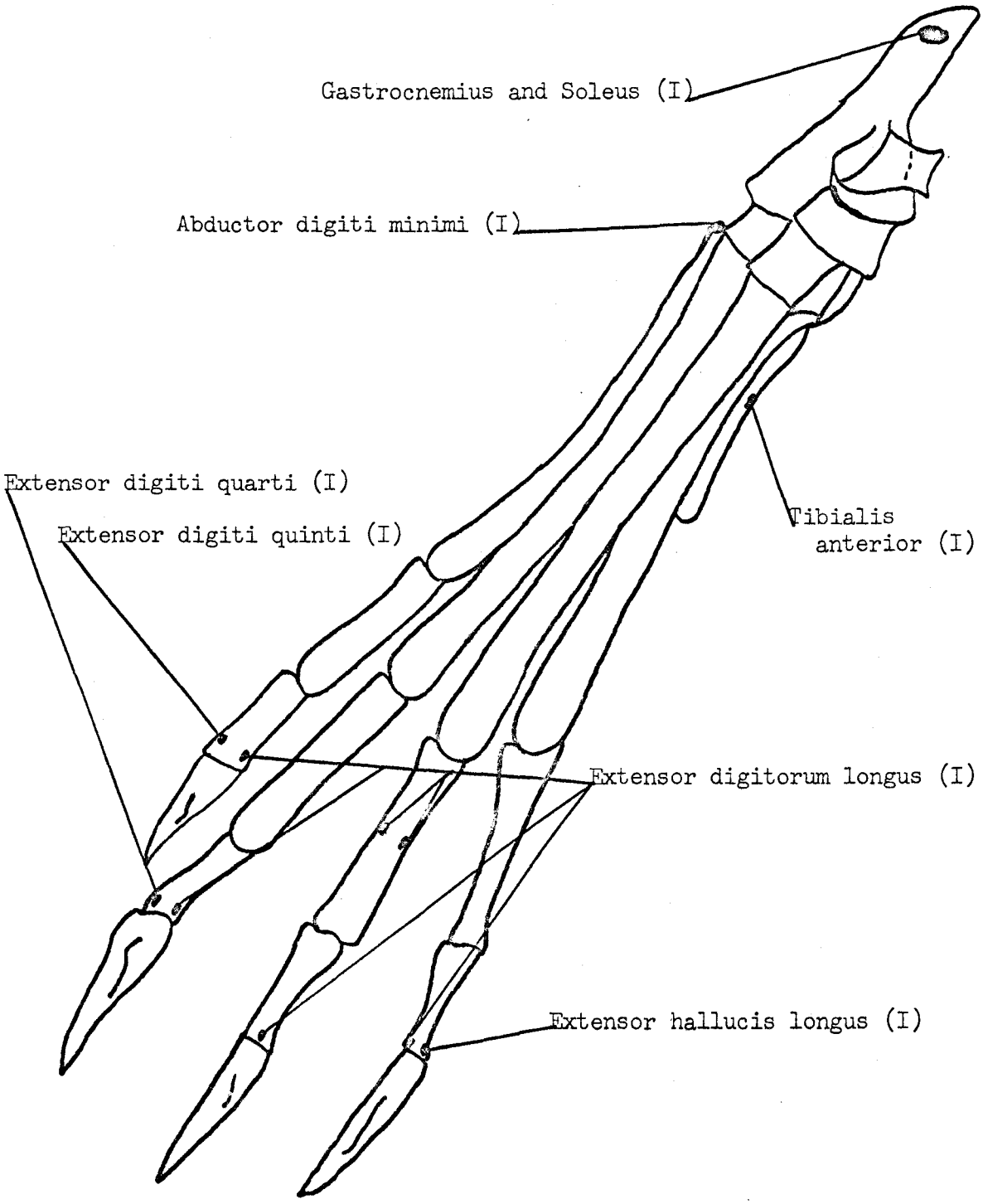

FIG. 8. DORSAL VIEW OF THE BONES OF THE FOOT OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Dipodomys ordii)

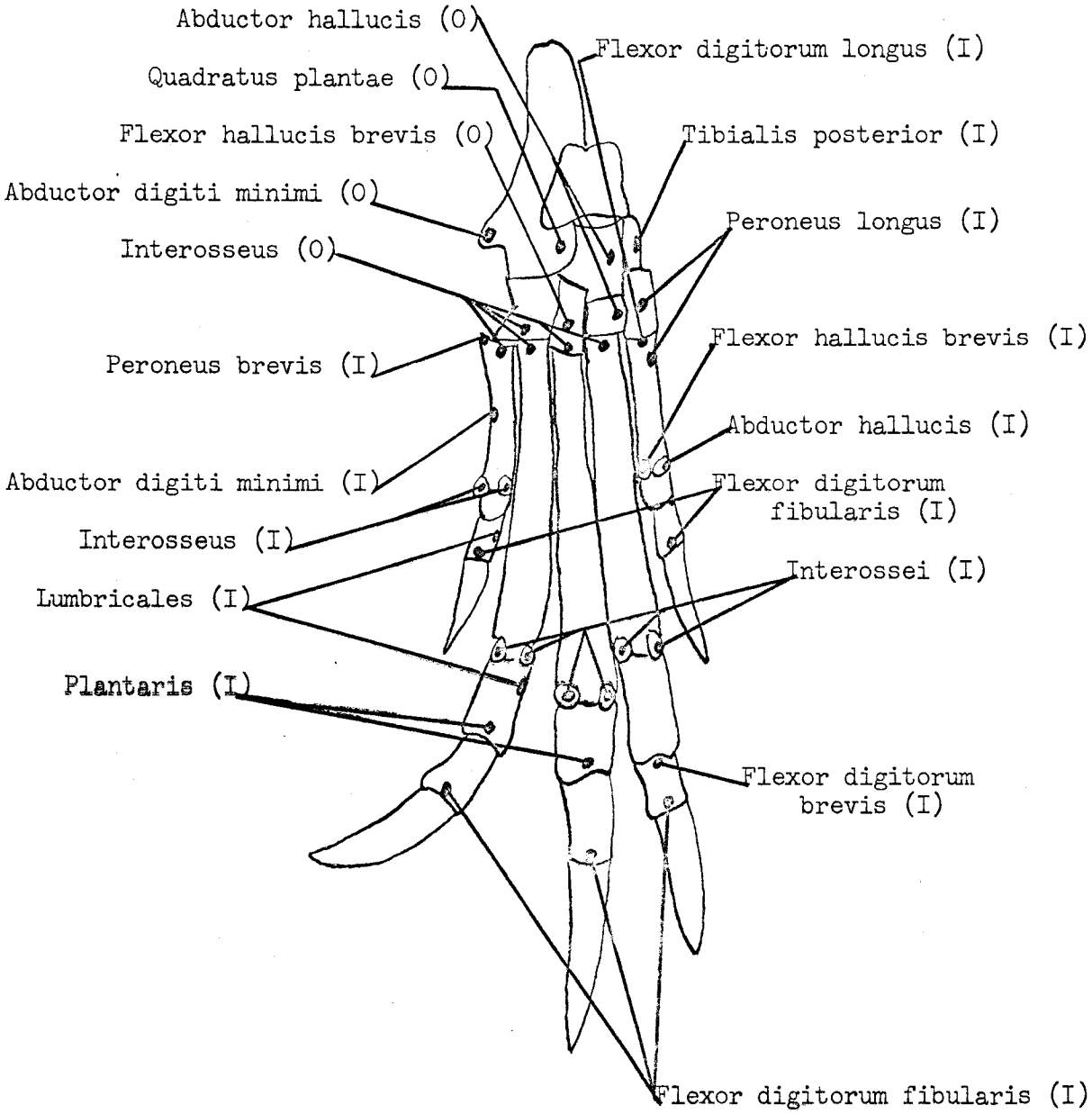

FIG. 9. PLANTAR VIEW OF THE BONES OF THE FOOT OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Thomomys umbrinus)

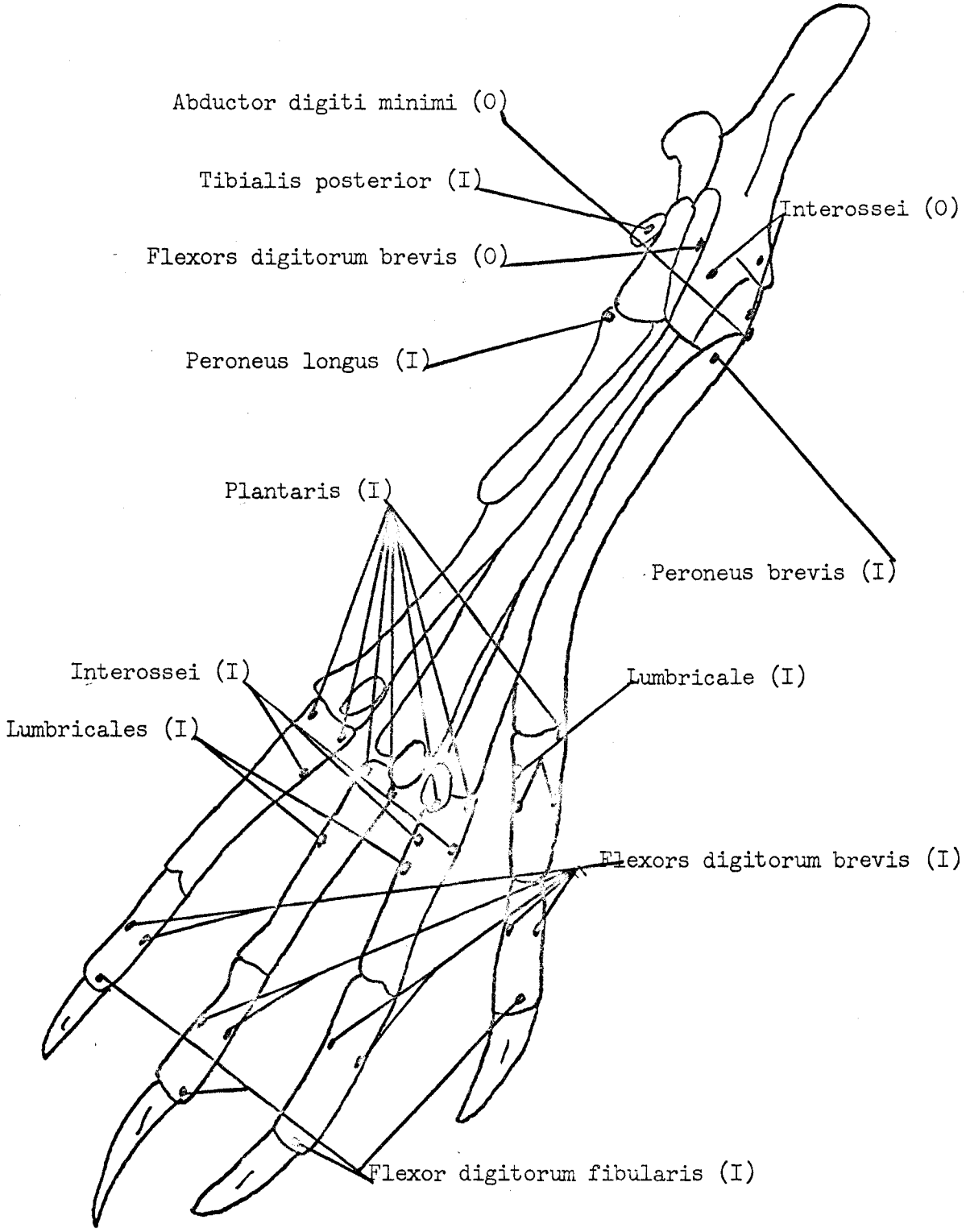

FIG. 10. PLANTAR VIEW OF THE BONES OF THE FOOT OF THE HIND LIMB SHOWING MUSCLE ORIGINS (O) AND INSERTIONS (I)

(Dipodomys ordii)

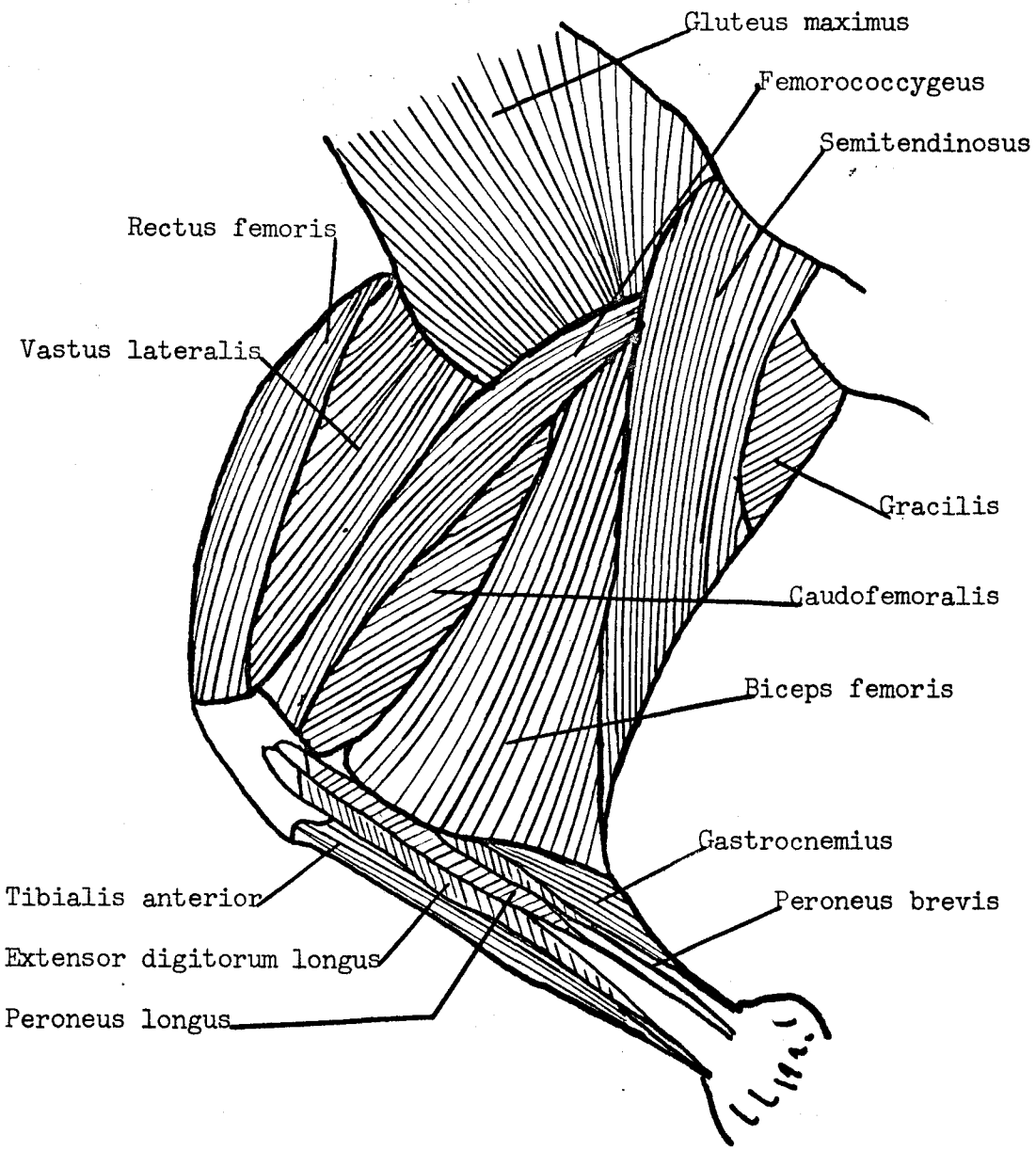

FIG. 11. LATERAL VIEW OF THE SUPERFICIAL MUSCLES

(Thomomys umbrinus)

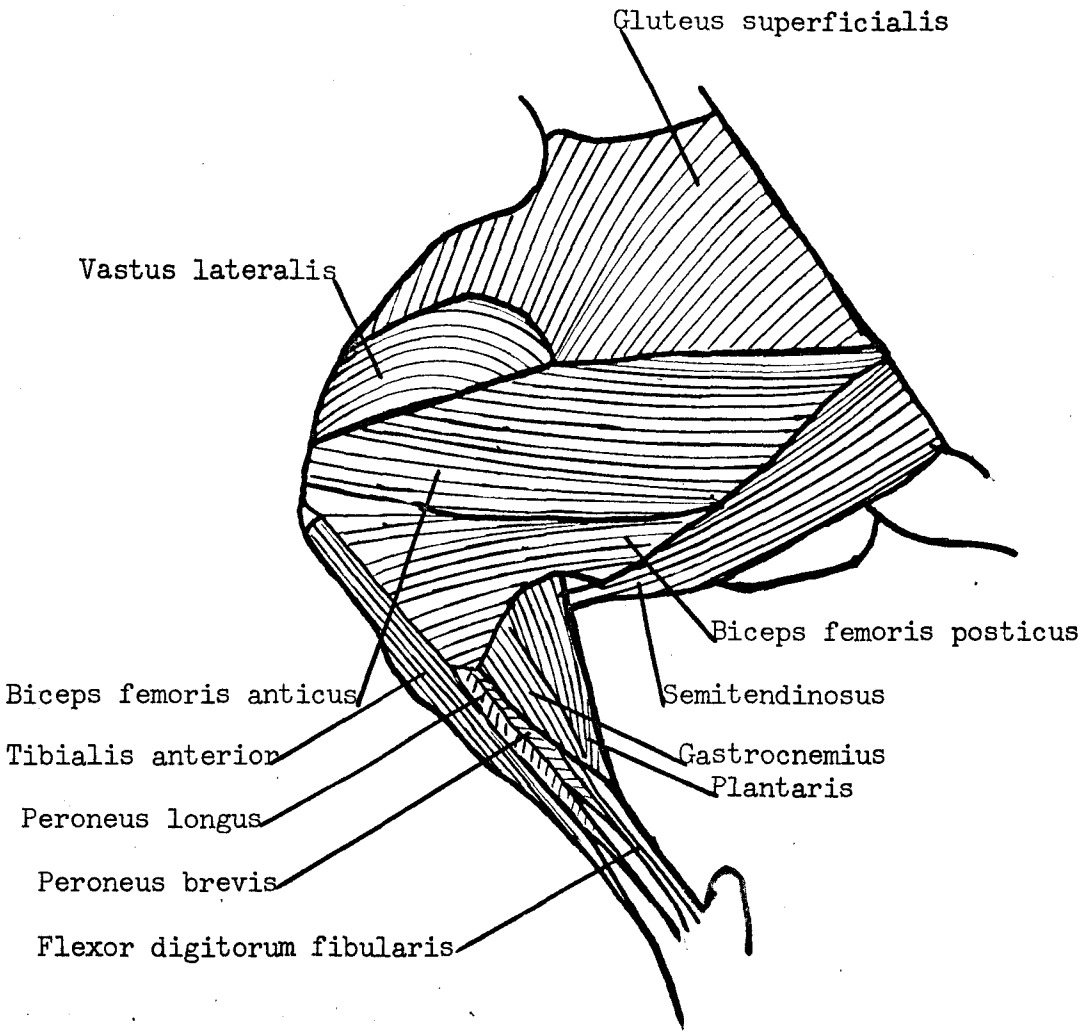

FIG. 12. LATERAL VIEW OF THE SUPERFICIAL MUSCLES

(Dipodomys ordii)

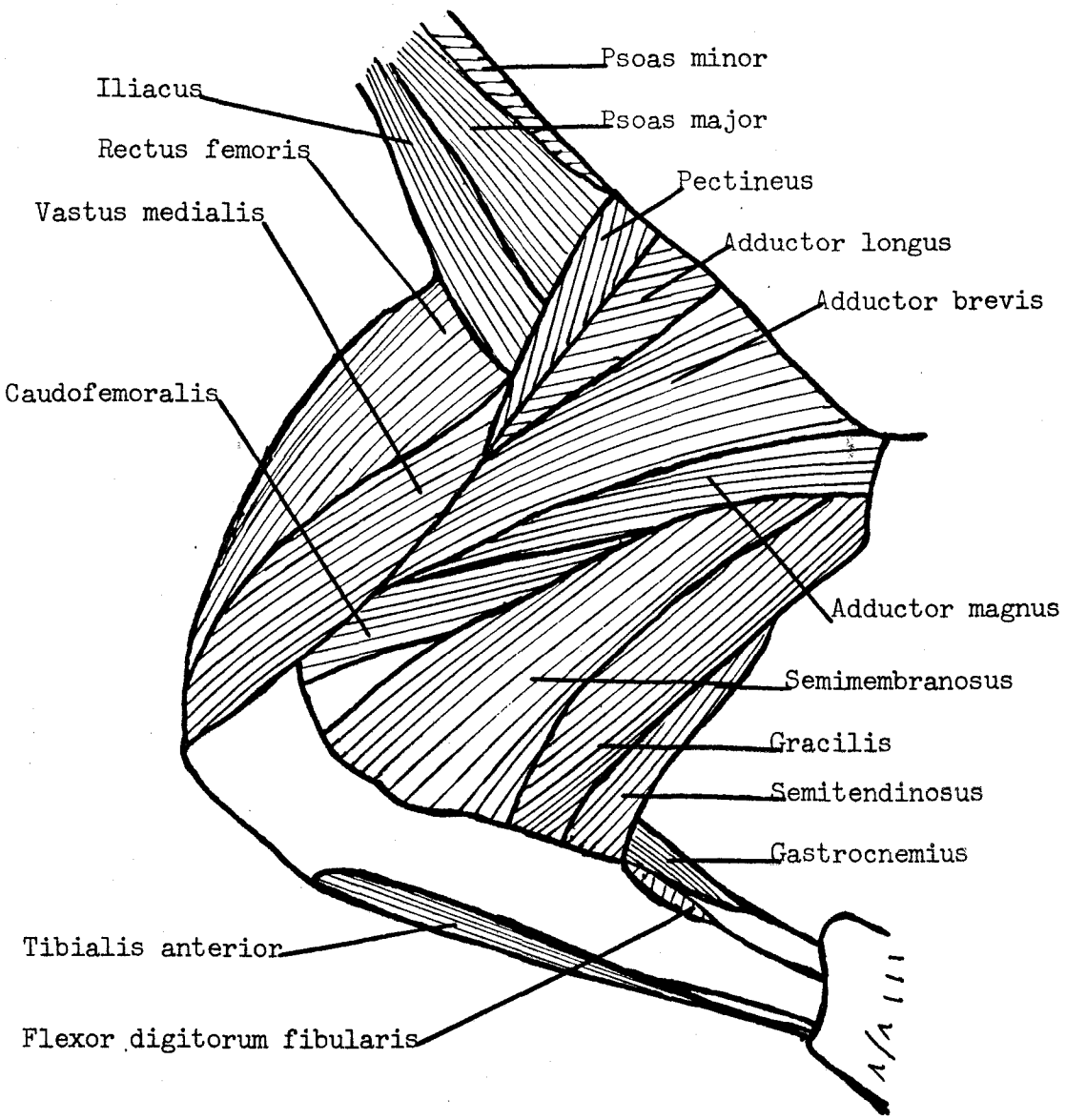

FIG. 13. MESIAL VIEW OF THE SUPERFICIAL MUSCLES

(*Thomomys umbrinus*)

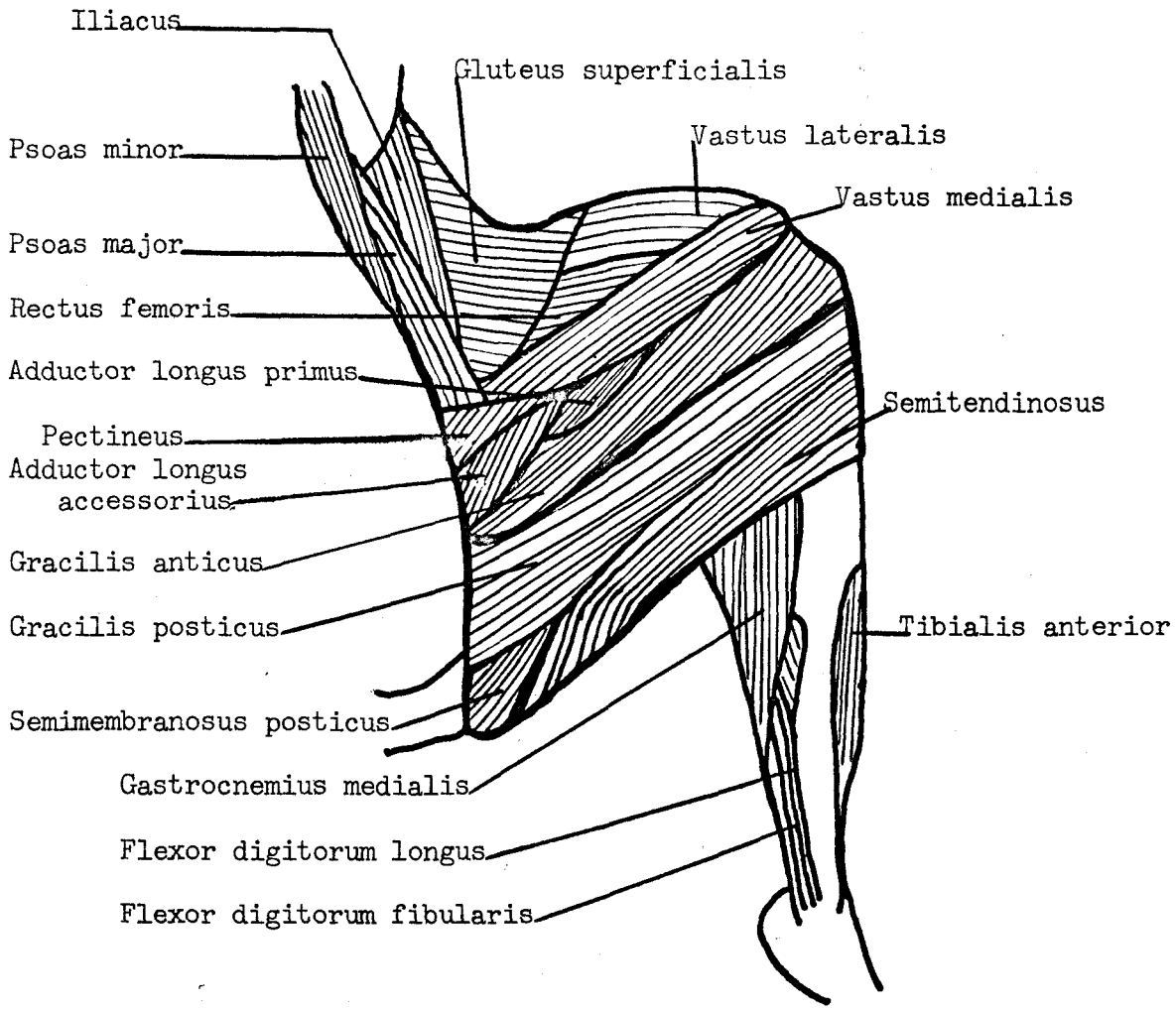

FIG. 14. MESIAL VIEW OF THE SUPERFICIAL MUSCLES

(Dipodomys ordii)

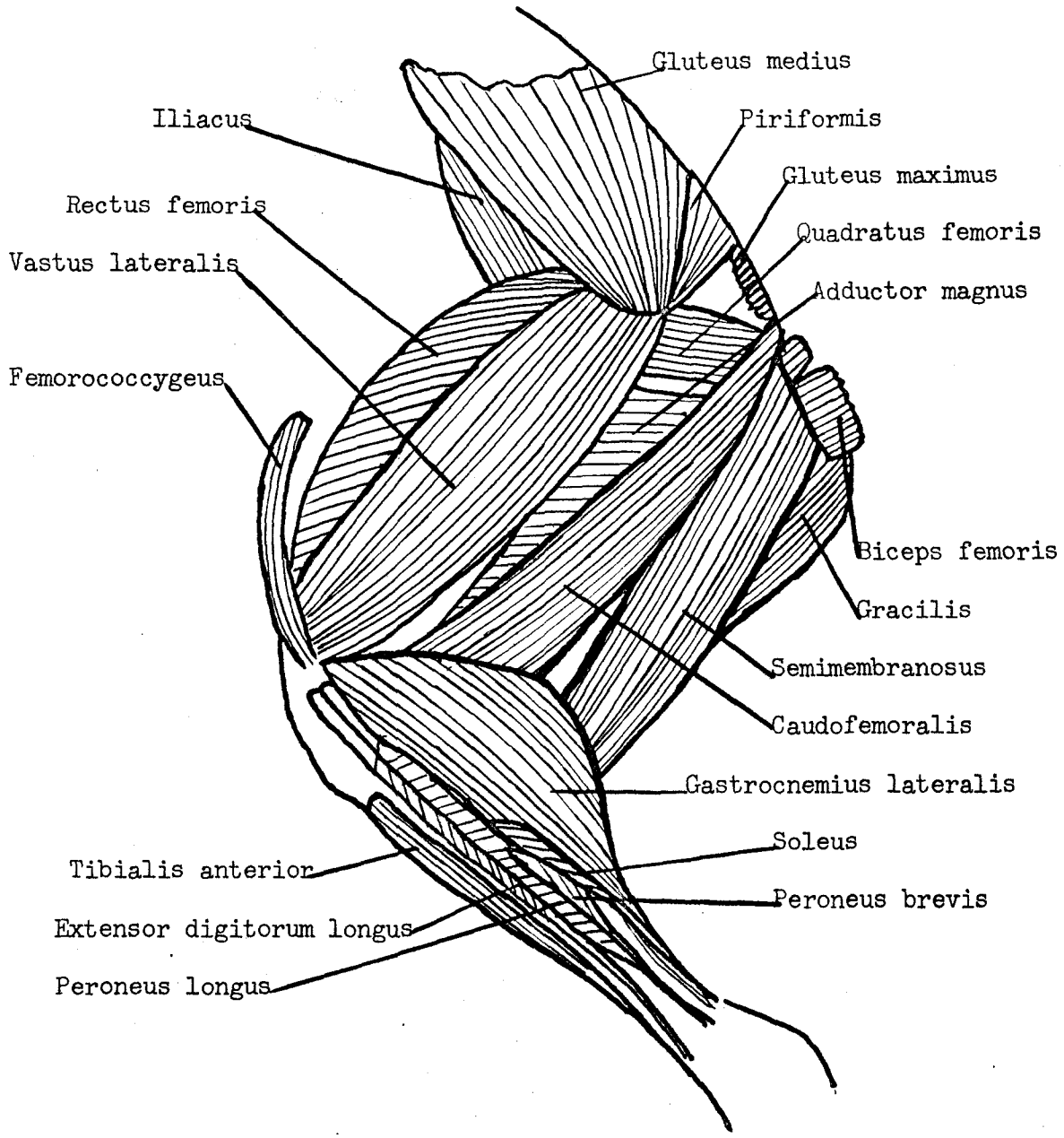

FIG. 15. LATERAL VIEW OF THE DEEP MUSCLES

(Thomomys umbrinus)

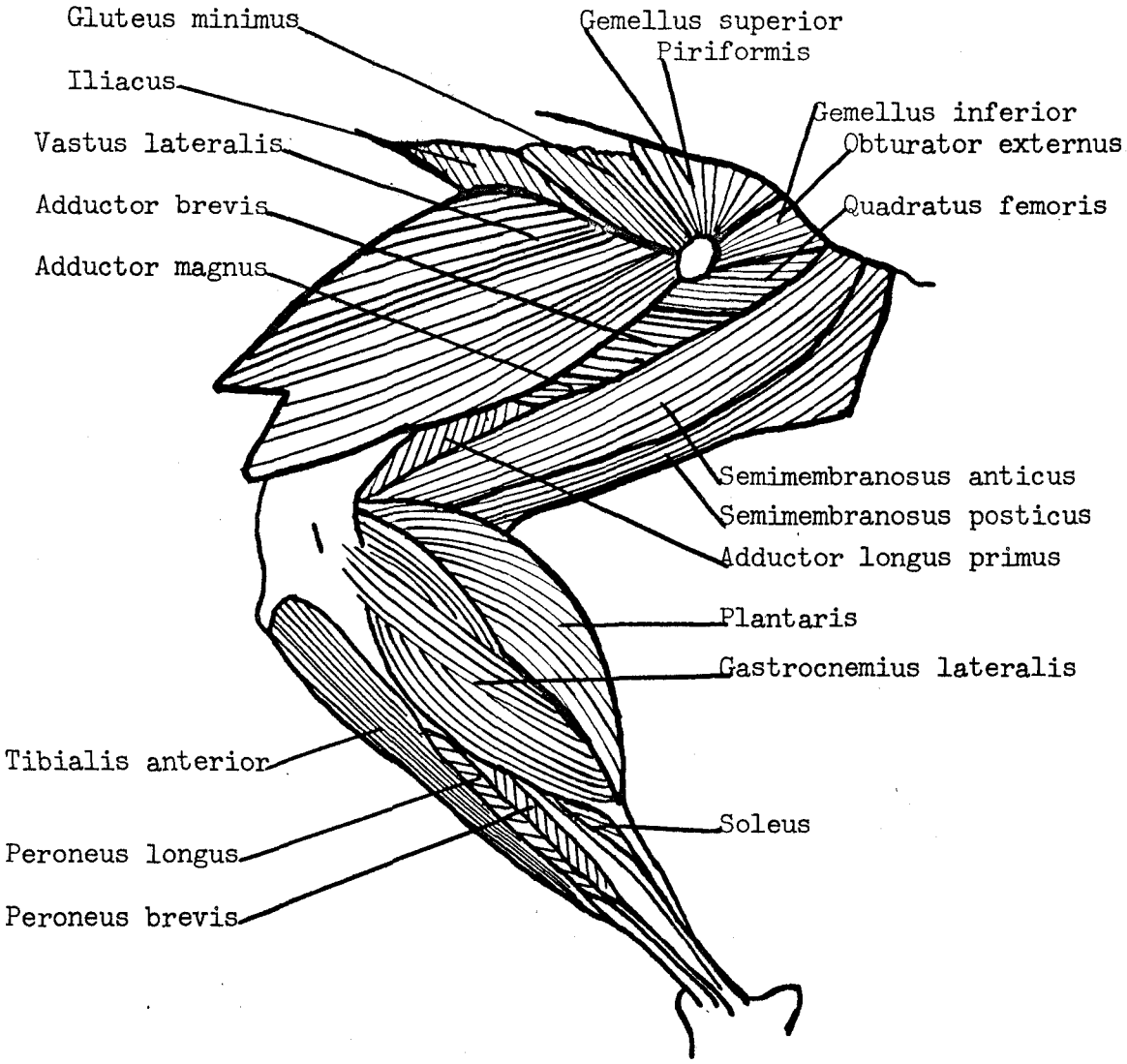

FIG. 16. LATERAL VIEW OF THE DEEP MUSCLES

(Dipodomys ordii)

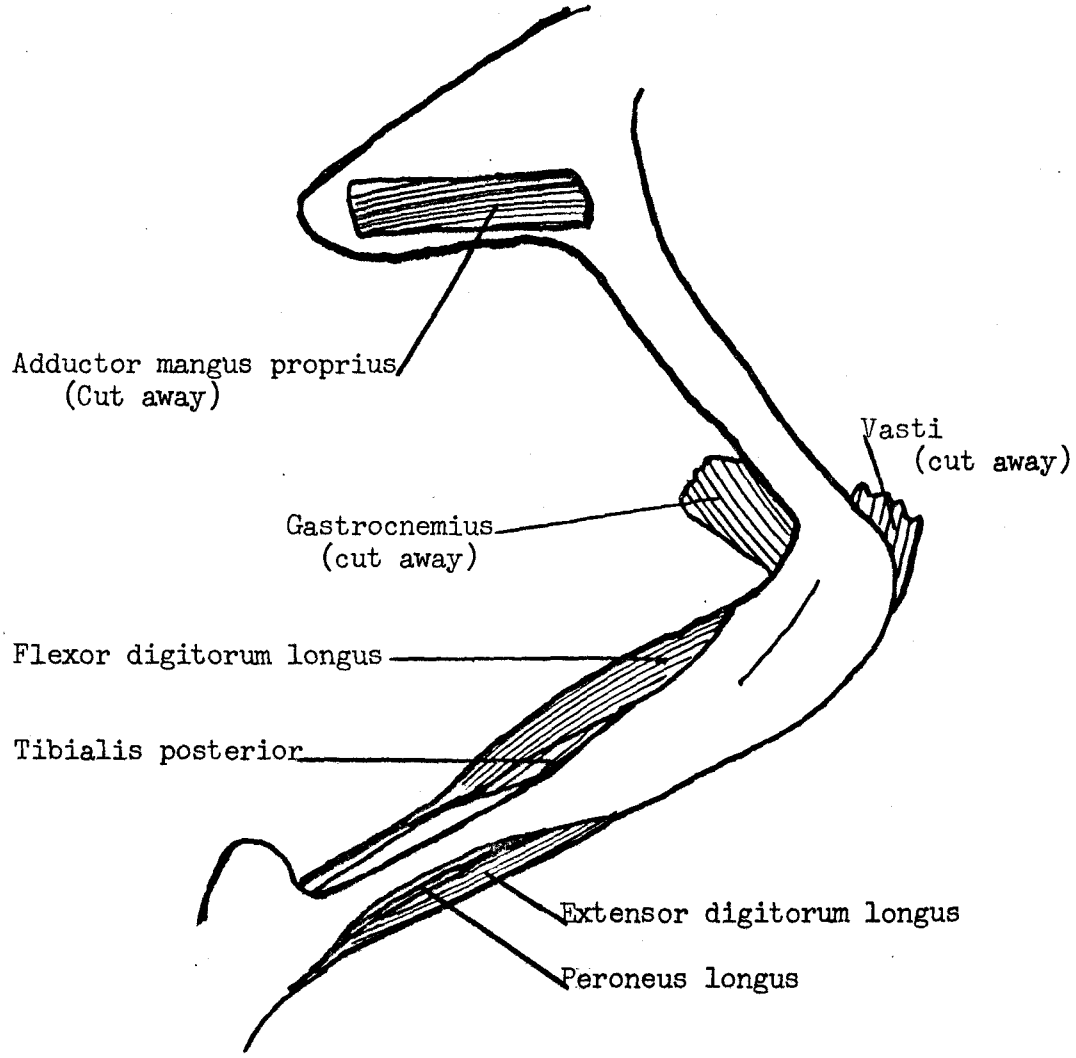

FIG. 17. MESIAL VIEW OF THE DEEP MUSCLES

(Thomomys umbrinus)

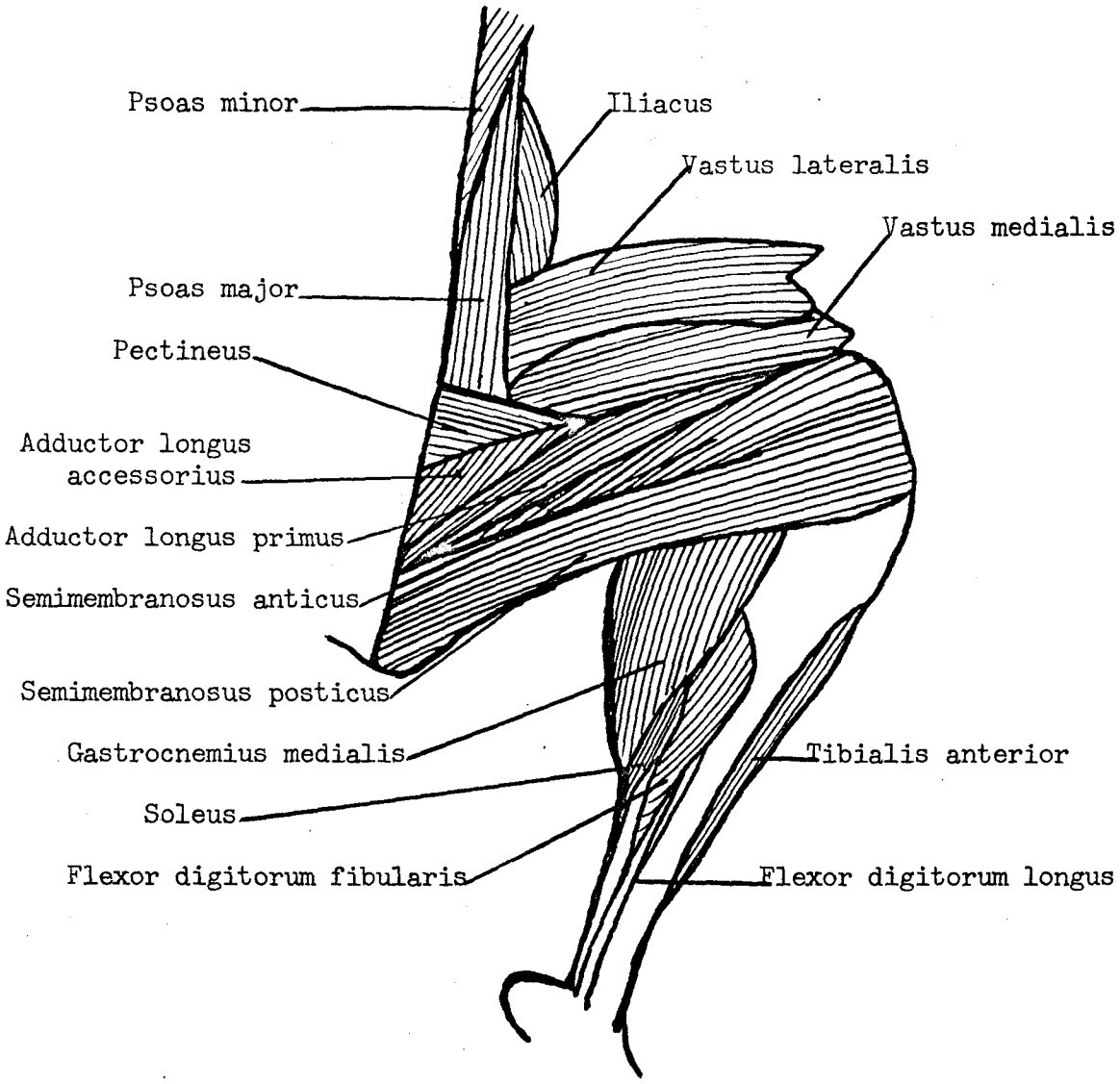

FIG. 18. MESIAL VIEW OF THE DEEP MUSCLES

(Dipodomys ordii)

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A COMPARATIVE STUDY OF THE OSTEOLOGY AND MYOLOGY OF THE HIND LIMB OF THE POCKET GOPHER AND KANGAROO RAT

An Abstract of

A Thesis

Presented to the

Department of Zoology and Entomology

Brigham Young University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Nancy S. Price

July, 1963

ABSTRACT

The purpose of this study was to compare the morphology of the hind limb of the pocket gopher with that of the kangaroo rat and to determine their differences. This was accomplished by first, obtaining the specimens; second, preparation of the specimens for preservation and dissection; third, photographing and tracing the muscles; fourth, noting the origin and insertion of each muscle and their general morphology; and fifth, preparation and photographing of the bones.

Comparative volumetric measurements were made of the muscles of the two animals to determine the differences between them. These two families, Geomyidae and Heteromyidae, are closely related but show great morphological differences which are adaptive due to their different environments and habits. The volumetric measurements of the two animals showed the shank of the kangaroo rat to be twice the size of that of the pocket gopher. The muscles used by the kangaroo rat in jumping are longer and larger as indicated by the volumetric displacement and linear measurements. Also, linear measurements were made of the various muscles and bones. These measurements also showed the variation in length and width, with those muscles of the kangaroo rat being longer and wider. In the study of the bones, the general outlines of the two forms were vastly different. The location of tuberosities, size of these tuberosities for muscle attachment, bone length and width made up these differences.

Origins, insertions, actions and descriptions of the muscles are given for each animal.

APPROVED: