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Myology of the pectoral girdle of the golden hamster

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MYOLOGY OF THE PECTORAL GIRDLE OF THE GOLDEN HAMSTER

by

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INTRODUCTION

This paper deals with the myology of the pectoral girdle and brachium of the golden hamster (Mesocricetus auratus). The material presented herein is the result of research carried on under the guidance of Dr. Ralph Priddy. The myology of the hamster has been compared with that of various other closely related rodents. Differences or similarities have been noted under the discussion concerning the particular muscles on the shoulder girdle of the hamster.

I am indebted to Dr. Priddy for suggesting the problem and for his continued guidance and assistance. I also wish to thank Donald Dunbar for helping to prepare the diagrams in this thesis.

Review of the Literature

There is hardly any literature on the musculature of the golden hamster. None of the rarer rodents have a very extensive literature.

Parsons (1894) made an extensive and thorough study of sciuromorphine and hystricomorphine rodents. He followed this in 1896 with a study of myomorphine rodents and a comparative study of various suborders of rodents. During his work he dissected a total of nine members of the family Muridae. Among these were examples of Cricetus frumentarius and Cricetomys gambianus.

Zuckerhandl-Tandler (1910) published a comparative study of the pectoral musculature. Included in this were the guinea-pig (Cavia cobaya) and the rabbit (Lepus cunniculus).

Hollinger (1916) made a survey of adaptations in the thoracic limb of the California pocket gopher (Thomomya bottae) and compared several other rodents with it. He used the following rodents: California ground squirrel (Citellus beecheyi), brown rat (Epimys norvegicus), Sacramento Valley cottontail (Sylvilagus auduboni), California jack rabbit (Lepus californicus), Belgian hare (Lepus europaeus) and the Sierra Chickaree or red squirrel (Sciurus douglasi albolimbatus).

Langworthy (1925) made a study of the M. panniculus carnosus and showed its genetical relationships in various rodents. He included a discussion and diagrams of the muscles in the rabbit, rat, porcupine and guinea-pig.

Howell (1926) published a work on the anatomy of the wood rat (Neotoma) and in the following pages extensive reference has been made to this work. Howell, being a myologist, ignores the other anatomical systems except osteology. He made a study of the osteology and myology of the saltatorial rodents in the genus Dipodomys, which was published in 1932. In 1937 he made a study of the morphogenesis of the shoulder architecture in therian mammals.

Greene (1935) published a work on the anatomy of the rat. A very complete and detailed study was made by him upon the albino rat commonly used in biological research. I have made repeated reference to this work in the following discussions on the muscles of the hamster. Unlike Howell (1926) Greene's book is a work that includes all the anatomical systems of the rat.

Bensley (1938) published a book on the anatomy of the rabbit which was very useful to my work.

Priddy and Brodie (1948) published the only recent work done on the morphology of the golden hamster. This paper deals with the musculature, nerves and blood vessels of the cheek pouches and very little reference is made to the shoulder girdle.

MATERIALS AND METHODS

For the present study ten animals were dissected; three adult laboratory rats and seven adult golden hamsters (*Mesocricetus auratus*). The specimens were preserved in embalming fluid consisting of formalin 1.5 parts, phenol (melted crystals) 2.5 parts, glycerine 10 parts and water 86 parts (Guyer, 1936). The animals were not treated any further since a myological investigation did not necessitate it.

The skeleton of the pectoral girdle and appendage of one golden hamster was prepared in order that the proper relations and anatomical landmarks could be located on the animals being dissected.

The muscles of the brachium and pectoral girdle can be roughly divided into three main groups depending upon their origins and points of insertion.

I

Muscles which have their origin on the skull or the axial skeleton and have their insertion either upon the scapula or the clavicle.

In the hamster the M. trapezius (fig. 3) is divided into three parts, the clavotrapezius, acromiotrapezius and spinotrapezius. There are only two divisions of the muscle in *Dipodomys*, as reported by Howell (1928), and also in many of the sciuromorphine and hystricomorphine rodents as dissected by Parsons (1894).

The M. clavotrapezius is the most anterior division of the trapezius and in the hamster it appears as a flat, ribbon-like triangular muscle which at its origin lies cranio-ventrad to the acromiotrapezius and cranio-dorsad to the cleidomastoideus. It takes its origin along the lambdoidal ridge, running from a point on the midline ventrad to the mastoid process. Near the middorsal line the origin is hidden by the origin of the acromiotrapezius, but it emerges very quickly and is then easily distinguishable for its entire length. From its origin this muscle runs caudo-ventrad, being close to the anterior border of the acromiotrapezius. As the clavotrapezius passes beneath the shoulder the atlantoscapularis muscle runs beneath it and separates it from the acromiotrapezius. Thence, the clavotrapezius passes to its insertion where it overlaps the insertion of the cleidomastoideus. The clavotrapezius has a muscular insertion upon the cranial surface of the clavicle starting about two-thirds of the clavicular length from the sternal end.

The M. acromiotrapezius is the middle portion of the trapezius group, or the anterior portion where the clavotrapezius is wanting. In the hamster this is a broad, thin, triangular muscle which covers most of the shoulder and neck area. Its origin is by muscle fibers extending caudad from the lambdoidal ridge to the fourth thoracic vertebra. These muscle fibers are attached to the middorsal line and to the tips of the first to the fourth thoracic vertebra. This muscle also has an extensive insertion which extends along the entire length of the cranio-lateral edge of the spine of the scapula.

The M. spinotrapezius is the posterior portion of the trapezius group and in the hamster it appears as a flat, triangular, ribbon-like muscle which is continuous with the posterior border of the acromiotrapezius. This muscle takes its origin along the middorsal line on the tips of the spines from the fourth to the twelfth thoracic vertebra. At the posterior border of its origin it lies on top of the latissimus dorsi. The spinotrapezius muscle has its insertion on the caudo-lateral edge of the proximal one-third of the spine of the scapula, in common with the insertion of the acromiotrapezius. The spinotrapezius covers the axillo-vertebral angle of the scapula.

This particular division of the trapezius showed some variation in the specimens that I dissected. In most of the animals the anterior border of the spinotrapezius was continuous with the posterior border of the acromiotrapezius. However, in several specimens, both in the rat and in the hamster, there was a gap between the origins of the two parts. In some cases the spinotrapezius began its origin about the sixth or seventh thoracic vertebra, and continued it to the twelfth thoracic vertebra. In these cases the axillo-vertebral angle of the scapula was visible between the acromiotrapezius and the spinotrapezius.

In the laboratory rat (Greene, 1935) the origin of the spinotrapezius extended caudad to the third lumbar vertebra. The caudal portion of this origin was an aponeurotic sheath, rather than muscle fibers. This condition is also present in the rabbit (Bensley, 1938). The trapezius muscle presents an interesting modification in the pocket gopher (Hollinger, 1916). In this fossorial rodent the relative size of the parts is quite different than in the rat or hamster. The cervical portion (clavotrapezius) is greatly elongated caudally so that it occupies the same position as the acromiotrapezius does in the other animals with which this study deals. Whereas the cervical portion is enlarged, the middle and thoracic portions are correspondingly abbreviated. Since the insertions of the cervical and middle portions occupy the same position as that occupied by the acromiotrapezius and clavotrapezius it is probably safe to assume that the clavotrapezius has been united with the acromiotrapezius with a concomitant slight shift in area of insertion.

The M. sternomastoideus (fig.6) in the hamster is almost circular in cross-section and is a small muscle which is only about 1.5 cm. in length. Its origin is a muscular-tendinous one from the cranio-latero-ventral surface of the manubrium. The origin lies over the clavicle at its sternal end. Its insertion consists in part of muscle fibers, but the main attachment is by a tendon affixed to the lateral surface of the mastoid process. At its insertion the sternomastoideus is in close proximity with the cleidomastoideus. The sternomastoideus cannot legitimately be considered as part of the musculature of the pectoral girdle. However, its close proximity to the cleidomastoideus and its superficial appearance of originating upon the clavicle warrants the short description of it given above.

The M. cleidomastoideus (fig. 6) is in very close association with the sternomastoideus along its entire length. The cleidomastoideus muscle in the hamster is a thin, circular one which arises from the mid-portion of the cranial surface of the clavicle. At its origin it is partly covered by the insertion of the clavotrapezius. From its origin the cleidomastoideus runs craniad and dorsad to its insertion beneath the sternomastoideus on the caudal side of the mastoid process. This particular muscle is a conservative one and in the animals of this study it is practically identical in all respects.

An interesting problem concerning the origin and insertion of muscles is provoked by consideration of the cleidomastoideus. Howell (1926), describing the wood rat, says that the cleidomastoideus originates from the mastoid process of the squamosal, but in his description of Dipodomys (1932) he gives the origin of the cleidomastoideus as upon the clavicle. Parsons (1894) puts the origin of the cleidomastoideus upon the clavicle. Greene (1935) describes the muscle in the same way. Bensley (1938) in his description of the rabbit, places the origin of the cleidomastoideus upon the mastoid process. This ambiguity exists because upon the contraction of the muscle either the head is turned and depressed or the clavicle is pulled craniad, depending upon which structure is held rigid.

The M. subclavius is a distinct, cylindrical muscle that takes its origin upon the anterior surface of the first rib near the junction of the sternum. The insertion is upon the underside of the clavicle near its distal end.

This muscle as reported by Greene (1935) inserts upon the underside of the middle of the clavicle. This muscle is reported by Howell in the wood rat (1926) and in Dipodomys (1932).

The M. atlantoscapularis (Levator claviculae) (fig. 3) in the hamster is a thin, ribbon-like muscle about 1.5 cm. in length and is comparable in appearance with the cleidomastoideus. Its origin is by muscle fibers upon the latero-ventral surface of the transverse process of the atlas. It passes directly caudad beneath the sternomastoideus, cleidomastoideus, and clavotrapezius. It emerges from beneath the clavotrapezius and then lies upon the acromiotrapezius to its point of insertion. The atlantoscapularis takes its insertion in conjunction with the insertion of the acromiotrapezius and is partly muscular and partly aponeurotic upon the tip of the scapular spine.

This muscle is almost identical in the laboratory rat (Greene, 1935) where it inserts upon the metacromion process and in the wood rat (Howell, 1926) where it is chiefly an aponeurotic insertion upon the metacromion process. In the kangeroo rat (Howell, 1932) the insertion spreads to the adjacent part of the clavicle and in the myomorphine rodents examined by Parsons (1896) the insertion spreads along the spine of the scapula. In all the above animals the origin is upon either the ventral arch or transverse process of the atlas. However, Parsons (1894), in discussing the sciuromorphine and hystricomorphine rodents, notes that the levator claviculae (atlantoscapularis) can arise from the atlas as usual, but it can also arise from the basioccipital, behind the origin of the scalenius anticus.

This shift in attachment is very marked in the rabbit where the only comparable muscle is the levator scapulae major (Bensley, 1938) which has its origin upon the sphenooccipital synchondrosis, which is the cartilaginous union between the basioccipital and basisphenoid bones of the skull. The levator scapulae major (atlantoscapularis) has its insertion upon the metacromion process of the scapular spine.

It is interesting to note that in Felis domesticus (Reighard and Jennings, 1929) the levator scapulae ventralis has a double origin from the basioccipital bone and the transverse process of the atlas.

The M. occipitoscapularis (fig. 4) in the golden hamster is a thin, flat, ribbon-like muscle which is covered by the clavotrapezius and the acromiotrapezius. The occipitoscapularis takes its origin by muscle fibers along the lambdoidal ridge dorsad from the mastoid process for a distance of about .5 cm.. It has its insertion on the proximal portion of the cranial border of the scapula. The occipitoscapularis also has a muscular attachment along the vertebral border of the scapula from the spine to the anterior-vertebral border. At its insertion the occipitoscapularis covers the upper part of the supraspinatus muscle.

The occipitoscapularis is similar in the laboratory rat (Greene, 1935) and in the wood rat (Howell, 1926). There is a confusion of nomenclature concerning this particular muscle. Bensley (1938) treats this muscle as a part of the levator scapulae complex in the rabbit and he terms it the levator scapulae minor. The occipitoscapularis is considered by some anatomists as a part of the rhomboideus complex of muscles.

Parsons (1896) notes that in <u>Cricetus</u> the part of the rhomboideus capitis arising from the outer part of the occipital curved line is separated from the rest of the rhomboideus muscle and runs to the inner half of the spine of the scapula, covering part of the supraspinatus, instead of going to the vertebral border of the scapula. He notes further that in all the myomorphine rodents that he studied the rhomboideus capitis is a distinct muscle, while the major and minor rhomboidei are not separable one from the other. Parsons (1894), in his discussion of the sciuromorphine and hystricomorphine rodents, does not recognize a separate muscle corresponding to the rhomboideus capitis of the myomorphine rodents. Howell (1932) reports, in the kangeroo rat, a pars capitus of the rhomboideus which is very similar to the occipitoscapularis in the golden hamster.

The M. <u>levator scapulae</u> in the golden hamster is a thin, flat, rectangular muscle lying immediately beneath the subscapularis and continuous with the serratus magnus. It takes its origin by muscle fibers from the ventral surface of the tips of the lateral processes of the last three cervical vertebrae and by muscular digitations upon the latero-ventral surface of the first three ribs. It has a broad muscular insertion along the medial surface of the vertebral border of the scapula continuous with the insertion of the rhomboideus muscles. It lies on top of the intercostal muscles.

Howell (1926) reports that the levator scapulae originates from the transverse processes of the last five cervical vertebrae and the first four ribs. Its insertion is along the medio-dorsal border of the scapula between the insertion of the rhomboidei and serratus magnus. Greene (1935) reports that in the laboratory rat the levator scapulae loses its costal origin and only has a cervical origin from the lateral processes of the last four cervical vertebrae. The other authors all considered the levator scapulae as part of the serratus magnus complex.

The M. serratus magnus (fig. 4) in the hamster is a thin, triangular, digitated muscle which at its origin is in close proximity with the intercostal muscles and at its anterior border is practically continuous with the levator scapulae. It takes its origin by fleshy muscular digitations on the cranial surface of the third through the ninth rib. The serratus magnus passes beneath the latissimus dorsi to an insertion directly beneath, and slightly behind, the insertion of the rhomboideus posticus. The insertion of the serratus magnus is continuous with that of the levator scapulae and is by muscular fibers upon the axillo-vertebral angle of the scapula. The insertion of the serratus magnus is continued upon the medial surface of the vertebral border of the scapula for a very short distance where it merges with the insertion of the levator scapulae.

Greene (1935) reports that in the laboratory rat the serratus anterior takes its origin by fleshy digitations from the first to the seventh rib. Its insertion is similar to the insertion as found in the hamster. Howell (1926) reports that in the wood rat the serratus magnus has its origin from the cranial border of the fifth to the ninth rib. He notes that the serratus magnus is twisted upon itself in a very characteristic fashion at its insertion. This peculiar twisting was evident in all the animals that I dissected. Howell (1932) reports that in Dipodomys the serratus magnus complex is differentiated into a posterior (thoracic) portion and a cervical portion. The origin of the posterior part is by five slips from ribs two to seven, the posterior four of which interdigitate with four slips of the obliquus externus, while the anterior two arise from deep slips of the scalenius. He further states that the main cervical part is not separable save by its bundles of origin, which are apparently from the transverse processes of all the last six cervical vertebrae. In the kangeroo rat the insertion of the serratus magnus complex is upon the entire vertebral border of the scapula. Howell does not recognize a separate levator scapulae muscle.

Parsons (1894) reports that in the sciuromorphine and hystricomorphine rodents the serratus group of muscles can be divided into a serratus magnus and levator anguli-scapula (levator scapulae). These two muscles are in the same plane and usually have a continuous origin so that it becomes very difficult to define their line of demarcation. He reports that the serratus group of muscles arises from the transverse processes of several cervical vertebrae and from the sides of seven to nine of the anterior ribs by fleshy digitations. The insertion is onto the vertebral border of the scapula. Parsons also reports that in some animals there is a separate slip arising from the atlas. Parsons (1896) reports that in the myomorphine rodents the origin of the serratus muscle varies from the second to the seventh cervical vertebra and from the first to the tenth rib. He reports that in *Cricetus* the origin is from the third to the seventh cervical vertebra and from the first to the seventh rib. Parsons delineates a serratus posticus (serratus magnus) which in *Cricetomys* continues its origin back to the ninth rib. In the other myomorphine rodents the usual origin is from the fourth to the seventh rib.

In the rabbit (Bensley, 1938) the cervical portion of the serratus anterior arises from the transverse processes of the posterior five cervical vertebrae and the anterior two ribs. The thoracic portion takes its origin from the third to the ninth rib by slips alternating with those of the external oblique. There is a common insertion on the medial surface of the vertebral border of the scapula.

A composite view of the serratus magnus complex gives a muscle with a cervical and a thoracic origin. The cervical origin varies from the last six cervical vertebrae down to the last three cervical vertebrae. Its origin from the thoracic region includes the first ten ribs or various divisions of them.

The M. *rhomboideus anticus* (fig. 4) in the hamster is a flat, thin, triangular muscle which is covered by the acromiotrapezius. At its posterior edge it merges with the rhomboideus posticus. The rhomboideus anticus takes its origin along the middorsal line on the crests of the cervical vertebrae. It inserts onto the cranio-vertebral angle continuous with the insertion of the rhomboideus posticus.

In the wood rat (Howell, 1926) the origin extends to the spine of the first thoracic vertebra and the insertion is beneath that of the rhomboideus posticus. In Dipodomys (Howell, 1932) the pars dorsi (rhomboideus anticus) inserts upon the entire vertebral border of the scapula. In the rabbit (Bensley, 1938) the rhomboideus minor has its origin along the ligamentum nuchae but its insertion is greater than that found in the hamster. The insertion of the rhomboideus anticus occupies the anterior two-thirds of the vertebral border of the scapula.

The M. rhomboideus posticus (fig. 4) is so closely applied to the rhomboideus anticus that it is separated only with great difficulty. It is a flat, ribbon-like, rectangular muscle covered by the acromiotrapezius. The anterior border of the rhomboideus posticus is continuous with the posterior border of the rhomboideus anticus. The rhomboideus posticus takes its origin from the middorsal line and tips of the spines of the first two thoracic vertebrae. It takes its insertion by muscle fibers along the vertebral border of the scapula extending from the insertion of the rhomboideus anticus to the axillo-vertebral angle of the scapula.

In the wood rat (Howell, 1926) the origin of the rhomboideus posticus is chiefly from the greatly developed spine of the second thoracic vertebra. Parsons (1894) reports that in the sciuromorphine and hystricomorphine rodents the origin of the rhomboideus posticus continues caudad to include the third and fourth spines of the thoracic vertebrae. He does not make any reference to a posterior and anterior portion. He treats it as a single muscle. In the myomorphine rodents (Parsons, 1896) the rhomboideus capitis (occipitoscapularis) is a separate muscle while the rest of the rhomboideus muscle is undifferentiated. In the laboratory rat (Greene, 1935) there is no thoracic origin and the rhomboideus minor (rhomboideus anticus) comes from the spines of the first three cervical vertebrae and inserts upon the vertebral border at the termination of the scapular spine. The rhomboideus major (rhomboideus posticus) arises from the spines of the fourth to the seventh cervical vertebrae and inserts upon the vertebral border of the scapula, overlying the rhomboideus minor. In the rabbit (Bensley, 1938) the origin of the rhomboideus major (rhomboideus posticus) is from the spinous processes of the first seven thoracic vertebrae. Its insertion is on the posterior third of the vertebral border of the scapula. In the rabbit the two parts of the rhomboideus are continuous.

II

Muscles arising from the axial skeleton and the pectoral girdle and inserted on the humerus, for the most part at its proximal extremity.

The M. acromiodeltoideus (fig. 3) is a fibrous, bi-pennated, triangular muscle covering the foremost part of the shoulder, making the rounded contour of the shoulder. It has a two-headed origin. One head originates from the distal half of the lateral surface of the clavicle. The other head is continuous with the first and goes around the shoulder to the acromion process of the spine of the scapula, and also onto a small portion of the caudo-lateral surface of the spine, where it meets the origin of the spinodeltoideus. At its origin the acromiodeltoideus lies next to the clavotrapezius and the spinodeltoideus. Along its medio-ventral border it is in close proximity with the pectoralis. The acromiodeltoideus has a tendinous attachment to the ventral surface of the pectoral muscle and the fibers of the acromiodeltoideus converge to a small point upon the latero-cranial surface of the base of the deltoid tuberosity of the humerus.

A similar condition exists in the pocket gopher (Hollinger, 1916), the laboratory rat (Greene, 1935), the wood rat (Howell, 1926), the kangeroo rat (Howell, 1932) and also in the sciuromorphine, hystricomorphine and myomorphine rodents examined by Parsons (1894 and 1896).

The M. spinodeltoideus (fig. 3) is a flat, ribbon-like, triangular muscle which at its origin lies on top of the infraspinatus. The spinodeltoideus takes its origin by muscle fibers along the caudo-ventral surface of the scapular spine from a point just behind the acromion process to the end of the spine. The origin is practically continuous with that of the acromiodeltoideus. The spinodeltoideus passes over the triceps and biceps brachii to an insertion along the lateral border of the deltoid tuberosity of the humerus, near its distal two-thirds. The spinodeltoideus lies beneath the acromiodeltoideus at its insertion. The deltoid complex is a conservative muscle complex which in all the hamsters studied ran between the spine of the scapula and the deltoid tuberosity of the humerus.

Howell (1926) and Parsons (1894 and 1896) state that the deltoid complex is composed of three parts: the spinal, acromial and clavicular portions. These parts are more or less fused. In the sciuromorphine and hystricomorphine rodents (Parsons, 1894) the fibers of the clavicular portion of the deltoid complex extend to the elbow. In the myomorphine rodents (Parsons, 1896) the usual three parts are present but the intervals between them are hardly noticeable and they all insert onto the humerus at the same point. In the rabbit (Bensley, 1938) the clavicular portion of the deltoid complex is entirely lacking and the scapular portion has its origin from the infraspinous fascia.

The M. <u>supraspinatus</u> (fig. 4) is a thick, muscular mass which lies beneath the acromiotrapezius and touches the cranio-dorsal border of the subscapularis. The supraspinatus takes its origin by a deep muscular attachment to the anterior margin of the scapula, the entire supraspinous fossa, and upon the lateral surface of the scapular spine facing the fossa. The insertion is by a very tough tendinous attachment to the lateral surface of the greater tuberosity of the humerus.

In the laboratory rat (Greene, 1935) the insertion of the supraspinatus is upon the anterior margin of the head of the humerus. In the pocket gopher (Hollinger, 1916) the supraspinatus is divided into two parts: a superior and an inferior portion. The superior portion arises from the dorsal third of the supraspinous fossa. The inferior portion arises from a narrow line on the dorsal surface of the base of the proximal two-thirds of the spine of the scapula. There is a common tendinous attachment onto the greater tuberosity of the humerus.

The M. infraspinatus (fig. 4) is a thick, fibrous muscle in the hamster which is overlaid by the spinodeltoideus and the spinotrapezius. The posterior border of the infraspinatus is in close proximity with the teres major muscle. The infraspinatus originates from the entire infraspinous fossa and the lateral surface of the scapular spine facing the fossa. The infraspinatus takes its insertion by an aponeurosis which attaches to the greater tuberosity of the humerus. The infraspinatus muscle is similar in all the animals of this study.

The M. subscapularis (fig. 5) is a tendinous muscle whose medial surface lies on the serratus magnus and the levator scapulae. The posterior portion of the subscapularis is in close proximity with the teres major muscle. The subscapularis takes its origin by muscle and tendon fibers from the entire surface of the subscapular fossa. All the heads of the subscapularis have a common insertion on the lesser tuberosity of the humerus. The subscapularis muscle is similar in all the animals of this study.

The M. teres major (fig. 5) in the golden hamster is a rectangular, somewhat flattened, muscle which is overlaid by part of the insertion of the latissimus dorsi. The caudal border of the teres major is in close proximity with the border of the subscapularis. The origin of the teres major lies beneath the pectoralis. The origin of the teres major is by muscle fibers along the axillary border of the scapula. The insertion of the teres major is by a flattened tendon onto the medial surface of the shaft of the humerus, lying just beneath the insertion of the latissimus dorsi.

In the California pocket gopher (Hollinger, 1916) the origin of the teres major is greatly reduced and arises from an impression on the proximal one-fourth of the axillary border of the scapula. The fibers of the teres major join those of the latissimus dorsi and there is a common tendon formed which inserts just below the lesser tuberosity of the humerus. In the other animals of this study the origin of the teres major is usually a limited area on the proximal end of the axillary border of the scapula. In the hamster specimens that I dissected there was an extensive origin of the teres major on practically the entire axillary border of the scapula.

The M. teres minor is not a distinct muscle in the hamster. The teres minor should be considered an element of the infraspinatus muscle. The only sign that I could find of the teres minor was an indistinct tendon arising from the distal one-third of the axillary border of the scapula in the region of the origin of the caput longus of the triceps. The attachment of this tendon was upon the greater tuberosity of the humerus.

Parsons (1896) states that in the myomorphine rodents the teres minor is very rarely a distinct muscle and *Cricetomys* is the only animal in which it can be described as well marked. In the sciuromorphine and hystricomorphine rodents (Parsons, 1894) the teres minor is a separate muscle but it is very closely applied to the infraspinatus muscle. In the other animals of this study this muscle is a separate unit but it is closely applied to the teres major and the infraspinatus.

The M. coracobrachialis in the golden hamster is a flat muscle lying just beneath the short head and belly of the biceps. The coracobrachialis has an origin in common with the short head of the biceps which arises by a tendon from the coracoid process of the scapula, and from the under surface of the long head. The coracobrachialis has its insertion upon the latero-medial surface of the shaft of the humerus, from the junction of the two heads of the biceps to the medial epicondyle of the humerus.

In the sciuromorphine and hystricomorphine rodents (Parsons, 1894) the coracobrachialis consists of three distinct parts all arising from the tip of the coracoid process. The first part (rotator humeri) inserts onto the surgical neck of the humerus, the second part inserts onto the middle of the shaft of the humerus and the third part extends down to be inserted onto the internal condyle of the humerus. In the myomorphine rodents (Parsons, 1896) the second and third parts are usually found but are fused into a continuous insertion. In Cricetus and Cricetomys the parts have the same arrangement but in addition the first part, or rotator humeri, is present. Howell (1932) describes a pars profunda, or breve, and a pars media in the kangeroo rat. In the laboratory rat (Greene, 1935), the wood rat (Howell, 1926), the rabbit (Bensley, 1938) and the pocket gopher (Hollinger, 1916) no such condition is reported.

The M. pectoralis (fig. 6) may be divided into four parts:

1. The first part (superficial portion) is a flat, rectangular shaped muscle arising from the manubrium and cranial end of the sternum. There are also a few fibers arising from

the sternal end of the clavicle. The origin of the superficial portion lies on top of the cleidomastoideus muscle. The superficial portion of the pectoralis runs laterally and slightly caudad over the fibers of the second part. The insertion of the superficial portion is by muscle and tendon fibers upon the deltoid ridge of the humerus just above the insertion of the acromiodeltoideus muscle.

2. The second part of the pectoral muscle lies beneath the first part. The second part takes its origin from the entire length of the sternum. It is a flat, triangular muscle whose fibers converge to a tendinous insertion upon the deltoid ridge of the humerus just beneath the insertion of the first part. The second part also inserts by muscular fibers on the deltoid ridge in conjunction with the insertion of the acromiodeltoideus muscle. The second part of the pectoral covers the deeper portion of the muscle.

3. The third part (deep portion) takes its origin along the sternum from about the third sternebra caudad to the xiphoid process. The fibers of the third part are rougher than those of the first or second part. The fibers of the third part run laterad and craniad to an insertion along the deltoid ridge extending proximad from the insertion of the first and second parts to the upper extremity of the humerus in the region of the lesser tuberosity. The third part of the pectoral lies under the second part and at its insertion the third part lies beneath the acromiodeltoideus muscle.

4. The fourth part (abdominal portion) takes its origin along the midventral line from the xiphoid process caudad for a distance of 15 to 22 mm. The insertion of the fourth part is upon the upper shaft and head of the humerus.

In the laboratory rat (Greene, 1935) the entire pectoralis musculature is divided into two main divisions, the pectoralis minor and the pectoralis major. The pectoralis major is divided into a superficial portion and a deep portion. The pectoralis major is the same as the first part (superficial portion) of the pectoralis muscle in the hamster. Greene divides the pectoralis minor into three parts. The first part arises from the second to the fifth sternebra and is inserted onto the coracoid process of the scapula and onto the lesser tuberosity of the humerus. The second part arises from the fifth sternebra and inserts upon the proximal end of the deltoid ridge of the humerus. The third part (xiphihumeralis) arises from the xiphoid process and inserts onto the coracoid process of the scapula. The wood rat (Howell, 1926) lacks a superficial portion as described in the hamster. The pectoralis superficialis is comparable to the second part of the pectoralis in the hamster. The pectoralis profundus anterior in the wood rat is comparable to the third part as described in the hamster. The wood rat has a xiphihumeralis (pectoralis profundus posterior) which inserts upon the deltoid ridge of the humerus. The pectoralis abdominalis in the wood rat has its origin by muscle fibers from the midventral line behind the xiphihumeralis and by fascia extending laterally to the abdominal external oblique muscles. The insertion of the pectoralis abdominalis is upon the head of the humerus. In the kangeroo rat (Howell, 1932) approximately the same condition exists but Howell divides the pectoralis muscle into four parts at the origin and two parts at the insertion.

In the sciuromorphine and hystricomorphine rodents (Parsons, 1894) the pectoral musculature is similar to that found in the hamster but in addition there is a deep portion which arises from some of the true ribs and inserts on the outer part of the clavicle, coracoid process, or shoulder capsule. In the myomorphine rodents Parsons (1896) notes that in Cricetomys the first part runs horizontally between the anterior part of the sternum and the pectoral ridge of the humerus. The second part arises from the entire length of the sternum and the abdominal fibers are feebly marked. The fourth part arises from the lower true rib cartilages and run forward and outward to the head of the humerus and the coracoid process of the scapula. The pectoralis muscle in the rabbit (Bensley, 1938) has one distinct element not found in the hamster, the pectoralis tertius. The pectoralis tertius has its origin from the manubrium to about the fourth sternebra and is attached, together with fibers from other muscles, to the spine of the scapula. This part of the pectoralis forms a broad fleshy mass covering the anterodorsal portion of the shoulder. The pectoralis tertius muscle in the pocket gopher (Hollinger, 1916) has a single origin and inserts on the mesial surface of the coracoid process of the scapula.

In the rat (Langworthy, 1925) there is a pectoralis abdominalis arising from the xiphoid process and linea alba and inserts onto the greater tuberosity and capsule of the shoulder joint. Greene (1935) reports that the insertion of the pectoralis abdominalis is upon the coracoid process. Langworthy (1925) found a very delicate fourth pectoral layer of muscles which had an aponeurosis from the sternum in the region of the second rib and is inserted onto the lower border of the fourth rib. In the guinea pig, Cavia cobaya, (Zucherhandle, 1910) the three major divisions of the pectoralis muscle (superficialis, profundus and abdominalis) are typical and have the same general relationships as in most rodents.

The M. latissimus dorsi (fig. 3) is a broad, flat, thin muscle covering an extensive area of the dorso-lateral surface of the thorax. The anterior portion lies underneath the spinotrapezius. The latissimus dorsi takes its origin from the middorsal line and upon the tips of the spines from the fourth to the twelfth thoracic vertebra. At about the level of the twelfth thoracic vertebra the muscle fibers fuse into an aponeurotic sheath that extends caudad into the lumbar region. The aponeurosis is so tightly applied to the underlying musculature that it cannot be entirely traced or isolated very far. As the muscle fibers of the latissimus dorsi pass through the axilla they become thick and circular. Near the insertion of the latissimus dorsi the epitrochlearis muscle makes its origin by muscle and tendon fibers on the ventrolateral surface of the latissimus dorsi. The latissimus dorsi muscle has its insertion by a thick, tough tendon onto the lateral surface of the shaft of the humerus about the middle of the deltoid tuberosity.

Greene (1935) traces the origin of the latissimus dorsi in the laboratory rat to the third lumbar vertebra. In the wood rat (Howell, 1926) the origin is from the eighth to the twelfth thoracic vertebra. Hollinger (1916) states that in the pocket gopher the origin of the latissimus dorsi is from the sixth to the twelfth thoracic spines, supraspinous ligament, and the lumbar fascia. He reports, as does Howell (1932) in the kangeroo rat, that there is a common insertion with the teres major. In the other animals of this study the latissimus dorsi follows the regular pattern.

The M. <u>epitrochlearis</u> (fig. 5) is a flat ribbon-like muscle which at its origin is in contact with the latissimus dorsi and lies over the medial head of the triceps. The epitrochlearis has a muscular origin from the latero-ventral edge of the latissimus dorsi near the tendon of the latter's insertion. The epitrochlearis has a muscular insertion, covering the inside of the elbow, upon the superficial fascia of the inner arm and elbow.

In the laboratory rat (Greene, 1935) the epitrochlearis arises by a tendon from the insertion of the latissimus dorsi and inserts upon the medial epicondyle of the humerus. The hamster and the wood rat (Howell, 1926) are identical in the structure and position of the epitrochlearis muscle. In the kangeroo rat (Howell, 1932) the insertion of the epitrochlearis is upon the olecranon process of the ulna. Parsons, in his comparative studies of rodent myology (1894 and 1896) does not mention the epitrochlearis muscle and neither does Bensley (1938) in discussing the rabbit.

III

Muscles arising from the scapula and humerus and inserted on the proximal ends of the radius and ulna.

The M. <u>anconeus</u> in the golden hamster is a flat muscle which lies in close proximity with the insertion of the triceps and with the muscles on the inner surface of the elbow. The anconeus takes its origin upon the medial epicondyle of the humerus and inserts upon the inner surface of the distal portion of the olecranon of the ulna.

This is the same condition as found in the pocket gopher (Hollinger, 1916) and in all the rodents studied by Parsons (1894 and 1896). Howell, in his work on the kangeroo rat (1932), does not mention the presence of an anconeus muscle.

The M. <u>triceps</u> (fig. 4) is divided into three parts:

1. The M. <u>triceps longus</u> in the golden hamster is the most prominent muscle of the arm, or foreleg. It is covered by the epitrochlearis and the insertion of the latissimus

dorsi. The triceps longus arises by tough, tendinous fibers along the distal half of the axillary border of the scapula. The insertion of the triceps longus is by a stout tendon onto the distal end of the olecranon process of the ulna.

2. The M. triceps lateralis is a flat band of muscle fibers in close proximity with the long head of the triceps and the brachialis muscle. The origin of the triceps lateralis is by a tough tendinous aponeurosis from the greater tuberosity of the humerus. The insertion is by an aponeurosis extending onto the caudal portion of the olecranon process of the ulna.

3. The M. triceps medialis is a thick-bellied muscle which lies in close proximity with, and is partly covered by, the triceps longus. The triceps medialis takes its origin by muscle fibers from the proximal portion of the medial surface of the shaft of the humerus. The insertion is by muscle fibers onto the olecranon process of the ulna in common with the insertion of the triceps longus.

In the pocket gopher (Hollinger, 1916) the triceps muscle is similar to that found in the hamster with the slight difference of a broader origin of the caput longum, which, in the gopher, arises from three-fourths of the axillary border of the scapula. In Dipodomys (Howell, 1932) the origin of the triceps longus is highly developed. It has a tendon from the axillary portion of the head of the humerus and there is also a fleshy origin which is not directly from the bone, but from an aponeurosis which passes from the acromion process of the scapula to the deep surface of the teres major and then around the axillary border of the scapula. The wood rat (Howell, 1926) is essentially the same as the golden hamster. In the laboratory rat (Greene, 1935) the triceps brachii is considered as one muscle possessing three distinct heads. There is a common insertion onto the olecranon process of the ulna. The rat has a slightly reduced origin of the caput longum, which only covers the ventral third of the axillary border of the scapula. Parsons (1894 and 1896), in his study of rodent myology, treats the triceps as one muscle with three heads. The origins are in the normal places but the inner head is usually inserted in front of the other two, on the olecranon process. Parsons states that in Cricetomys it was noted that the outer head was inserted largely into the fascia on the outer surface of the forearm.

The M. biceps brachii (fig. 5) is a thick muscle lying deep in the brachium. The biceps brachii takes its origin by two heads. The short head arises by a tendon from the coracoid process of the scapula. The long head arises by a tendon from the dorsal border of the glenoid cavity and runs through the intertubercular sulcus of the humerus. These two heads join part way down the shaft of the humerus and form the belly of the muscle. There is a common insertion by a tendon onto the tuberosity of the radius near the insertion of the brachialis.

Parsons (1894 and 1896) reports that the origin of the biceps branchii in all rodents has a strong tendon from the margin of the glenoid cavity at the base of the coracoid process. There may or may not be a second head from the tip of the coracoid process or the surface of the coracobrachialis. The biceps brachii has its insertion onto the radius, ulna, or both bones, just below the sigmoid cavity. However, the insertion, in some cases, may be prolonged farther down on the bones. In his discussion of myomorphine rodents Parsons (1896) states that one of the characteristics of the Myomorpha is a double-headed biceps. As a rule the insertion is onto both bones of the forearm but in his dissection of the biceps cubiti (biceps brachii) in Cricetus he found that the muscle only goes to the radius. In the pocket gopher (Hollinger, 1916) the biceps is very similar to that found in the hamster, but the insertion is on the ventro-mesial surface of the ulna and only slightly on the radius. The laboratory rat (Greene, 1935) is very similar to the condition in the hamster and the insertion is onto the tuberosity of the radius. In the rat there is a secondary portion which is inserted by a fibrous band (lacertus fibrosus) into the fascia covering the pronator teres. The biceps brachii in the wood rat (Howell, 1926) is identical with that in the hamster. In the kangeroo rat (Howell, 1932) the tendons of the heads of the biceps brachii remain separate throughout their lengths and twist about one another so that the one belonging to the long head is inserted with the brachialis upon the medial surface of the ulna while the one belonging to the short head has the usual insertion upon the bicipital tuberosity of the radius.

The M. brachialis (fig. 5) is a thick muscle which is in close proximity to, and partly covered by, the triceps lateralis. The brachialis is also in close touch with the biceps brachii. The brachialis takes its origin by two heads: one from the medial surface of the neck of the humerus and the other from the shaft of the humerus just below the greater tuberosity with a few fibers on the greater tuberosity. The insertion is upon the medial surface of the ulna just proximad to the radial insertion of the biceps brachii.

In the pocket gopher (Hollinger, 1916) there is a common insertion of the brachialis with the insertion of the biceps brachii. In Dipodomys (Howell, 1932) the insertion of the brachialis is common with the insertion of the long head of the biceps. Parsons (1896) reports that in the Myomorpha the insertion of the brachialis is always onto the ulna alone. In the rabbit (Bensley, 1938) the insertion of the brachialis is common with the insertion of the biceps, which is onto both the radius and the ulna.

CONCLUSIONS

1. The trapezius complex in the golden hamster is clearly divided into three distinct elements: the M. _clavotrapezius_, M. _acromiotrapezius_ and M. _spinotrapezius_.

2. The M. _occipitoscapularis_ in the golden hamster is a distinct and separate muscle.

3. The M. _levator scapulae_ and M. _serratus magnus_ in the golden hamster are both separate and distinct muscles.

4. The rhomboideus complex in the golden hamster is divided into two distinct and separate muscles: the M. _rhomboideus anticus_ and M. _rhomboideus posticus_.

5. The deltoid complex in the golden hamster is divided into two muscles: the M. _acromiodeltoideus_ and M. _spinodeltoideus_.

6. The M. _teres minor_ in the golden hamster is not distinguishable and is treated as part of the M. _infraspinatus_.

7. The M. _coracobrachialis_ is one distinct muscle in the golden hamster.

8. The M. _pectoralis_ is divided into four distinct parts in the golden hamster.

9. The M. _epitrochlearis_ is a distinct ribbon-like muscle in the golden hamster.

10. The triceps complex in the golden hamster is divided into three distinct muscles: the M. _triceps longus_, M. _triceps lateralis_ and M. _triceps medialis_.

11. The M. _biceps brachii_ in the golden hamster originates

by two heads and inserts onto the tuberosity of the radius.

12. The following muscles in the golden hamster do not have any marked differences from the usual relationships: M. sternomastoideus, M. cleidomastoideus, M. subclavius, M. atlantoscapularis, M. supraspinatus, M. infraspinatus, M. subscapularis, M. teres major, M. latissimus dorsi, M. anconeus, M. brachialis.

ABSTRACT

In the literature which is written on rodent myology there is not much reference made to the morphology of the golden hamster. Parsons (1896) reports on some hamsters that he dissected. Priddy and Brodie (1948) have published the only recent work on the morphology of the golden hamster.

This study is concerned with the myology of the pectoral girdle of the golden hamster. The pectoral girdle is compared with that of the laboratory rat (Greene, 1935), the wood rat (Howell, 1926), the kangeroo rat (Howell, 1932), the pocket gopher (Hollinger, 1916) and the rabbit (Bensley, 1938). Parsons' work on the comparative myology of the sciuromorphine, hystricomorphine and myomorphine rodents (1894 and 1896) is referred to extensively.

The following muscles are included in this study: M. clavotrapezius, M. acromiotrapezius, M. spinotrapezius, M. sternomastoideus, M. cleidomastoideus, M. subclavius, M. atlantoscapularis, M. occipitoscapularis, M. levator scapulae, M. serratus magnus, M. rhomboideus anticus, M. rhomboideus posticus, M. acromiodeltoideus, M. spinodeltoideus, M. supraspinatus, M. infraspinatus, M. subscapularis, M. teres major, M. teres minor, M. coracobrachialis, M. pectoralis, M. latissimus dorsi, M. epitrochlearis, M. anconeus, M. triceps longus, M. triceps lateralis, M. triceps medialis, M. biceps brachii and M. brachialis.

The origins and insertions of the following muscles had

the normal relationships in the golden hamster: sternomastoideus, cleidomastoideus, subclavius, acromiodeltoideus, spinodeltoideus, supraspinatus, infraspinatus, subscapularis, teres major, latissimus dorsi, anconeus, triceps longus, triceps lateralis, triceps medialis and brachialis.

The trapezius muscle in the hamster is clearly divided into three parts: clavotrapezius, acromiotrapezius and spinotrapezius. The origin of the spinotrapezius showed some variation in the animals that were dissected. The trapezius complex of muscles showed differences in the laboratory rat (Greene, 1935) and in the pocket gopher (Hollinger, 1916). The atlantoscapularis in the hamster arises from the atlas only, but in the rabbit the atlantoscapularis arises from the sphenoocipital synchondrosis. Parsons reports that in the sciuromorphine and hystricomorphine rodents (1894) the origin may be from either place mentioned above.

The occipitoscapularis is a distinct muscle in the hamster, laboratory rat and the wood rat. Bensley (1938) treats this muscle as a part of the levator scapulae complex. Parsons (1894 and 1896) and Howell (1932) treat the occipitoscapularis as part of the rhomboideus complex. The levator scapulae in the hamster originates from the lateral processes of the last three cervical vertebrae and from the first three ribs. The other animals in this study vary considerably as to points of origin. The serratus magnus in the hamster originates from the third to the ninth rib. The other animals in this study vary considerably as to points of origin. Most of the authors in this study treated the levator scapulae as part of the serratus magnus complex and treat them both as one muscle. Greene (1935) treats them as separate muscles and so does Howell (1926).

The rhomboideus complex in the hamster can be divided into a rhomboideus anticus and a rhomboideus posticus. Most of the authors consider them as one muscle consisting of two parts. Parsons (1896) considers the occipitoscapularis as a component of the rhomboideus complex and terms it the rhomboideus capitis.

The teres minor is not distinguishable as a separate muscle in the golden hamster and is treated as part of the infraspinatus complex. Parsons (1896) reports that this is true in all the Myomorpha. The other authors treat the teres minor as a distinct muscle.

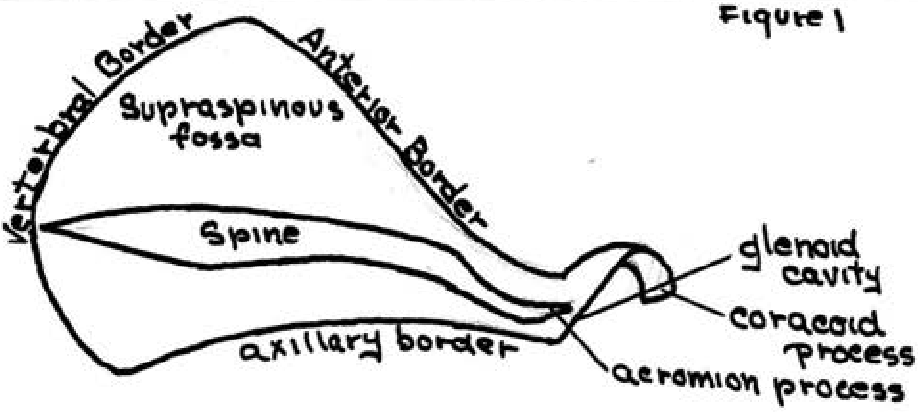
In the hamster the coracobrachialis is treated as one muscle. Howell (1932) describes a pars profunda and a pars media in the kangeroo rat. Parsons (1894 and 1896) divides the coracobrachialis into three parts. The other authors included in this study treat the coracobrachialis as just one muscle.

The pectoralis muscle in the golden hamster is divided into four parts. The first and second elements insert upon the deltoid crest of the humerus while the third and fourth elements are inserted slightly higher on the shaft, head and tuberosities of the humerus. The laboratory rat (Greene, 1935) has a xiphihumeralis that inserts upon the coracoid process of the scapula. The wood rat (Howell, 1926) is very similar to the hamster in the morphology of the pectoralis muscle. Parsons (1894 and 1896) describes a fourth part arising from some of the true ribs and inserting onto the shoulder capsule. Bensley (1938) reports that in the rabbit there is a pectoral element running from the sternum to the spine of the scapula.

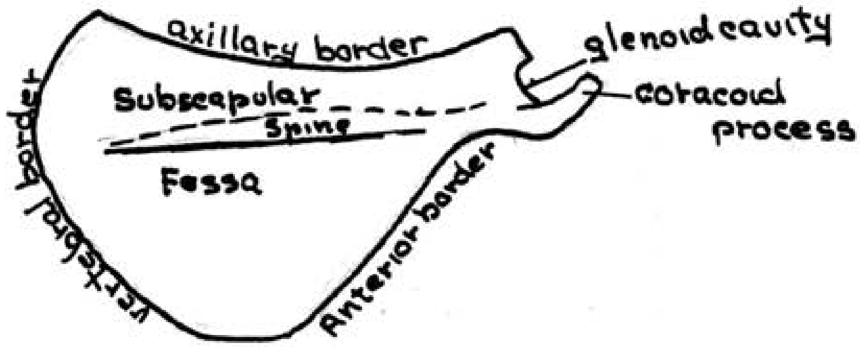
In the hamster and the wood rat the epitrochlearis runs between the latissimus dorsi and the inner elbow. In both animals it is a ribbon-like muscle and has a muscular origin and insertion. In the laboratory rat (Greene, 1935) the epitrochlearis is more compressed and has a tendinous origin and insertion. Bensley (1938) and Parsons (1894 and 1896) do not report this muscle.

The biceps brachii in the golden hamster has two heads as is characteristic of the Myomorpha (Parsons, 1896). The insertion of the biceps brachii varies slightly in the different animals of this study. In the pocket gopher (Hollinger, 1916) it inserts on the ulna. The insertion of the biceps brachii in the laboratory rat (Greene, 1935) is similar to that in the hamster, which is on the radius. The wood rat (Howell, 1926) is identical with the hamster. In the kangeroo rat (Howell, 1932) the two heads remain separate and the long head inserts upon the ulna while the short head inserts on the radius.

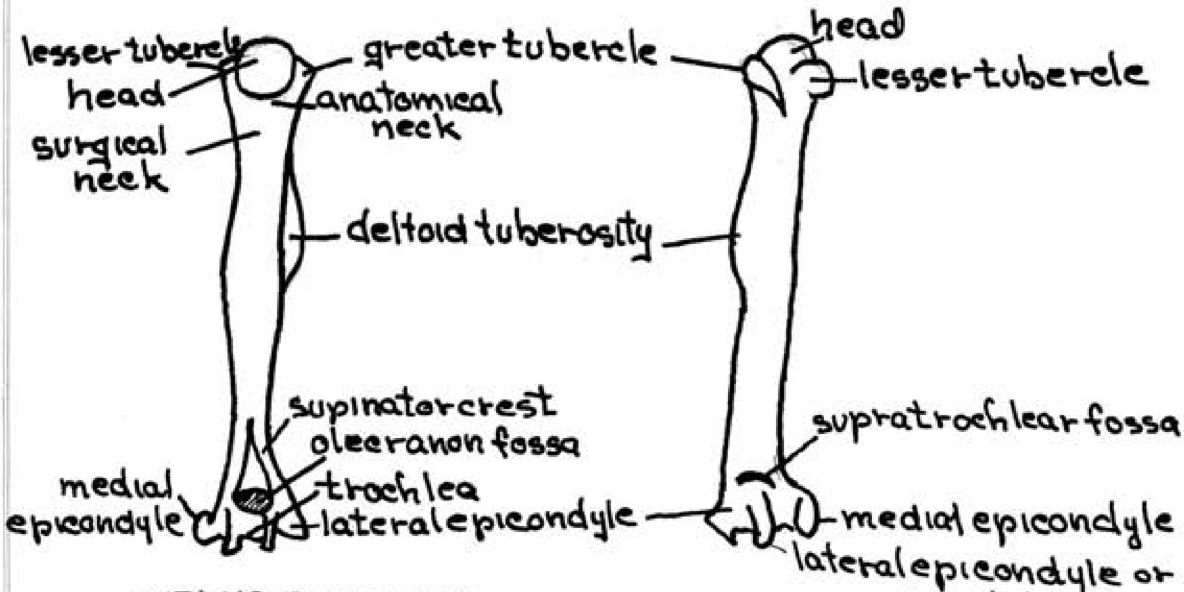
Figure 1



LATERAL ASPECT OF RIGHT SCAPULA



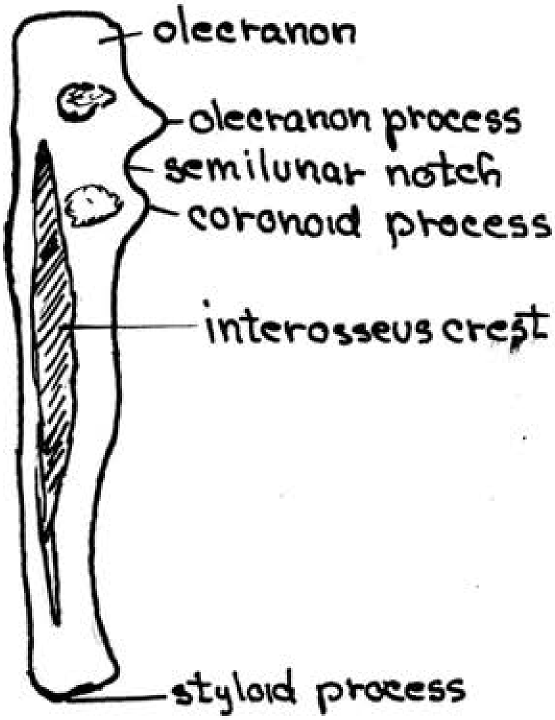
MEDIAL ASPECT OF RIGHT SCAPULA



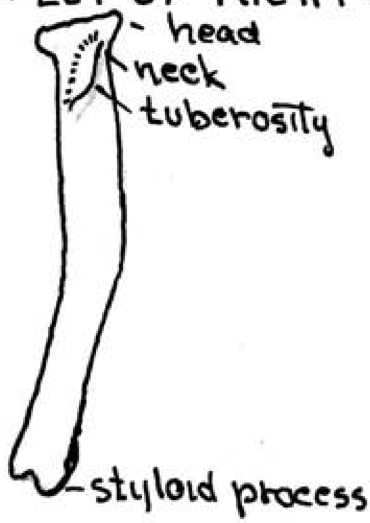
EXTENSOR SURFACE FLEXOR SURFACE

RIGHT HUMERUS

Figure 2



LATERAL ASPECT OF RIGHT ULNA

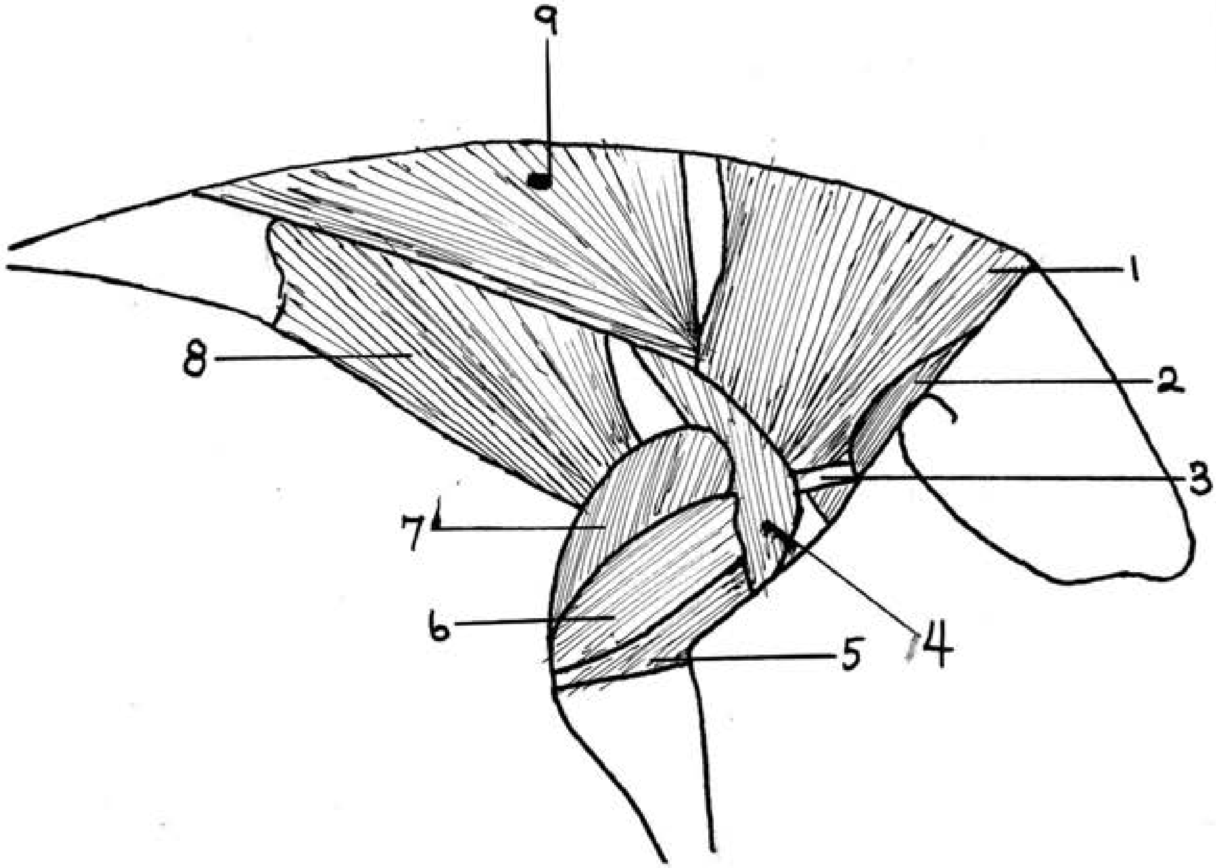


EXTENSOR SURFACE OF RIGHT RADIUS

VENTRAL ASPECT OF RIGHT CLAVICLE

Hamster II

Figure 3

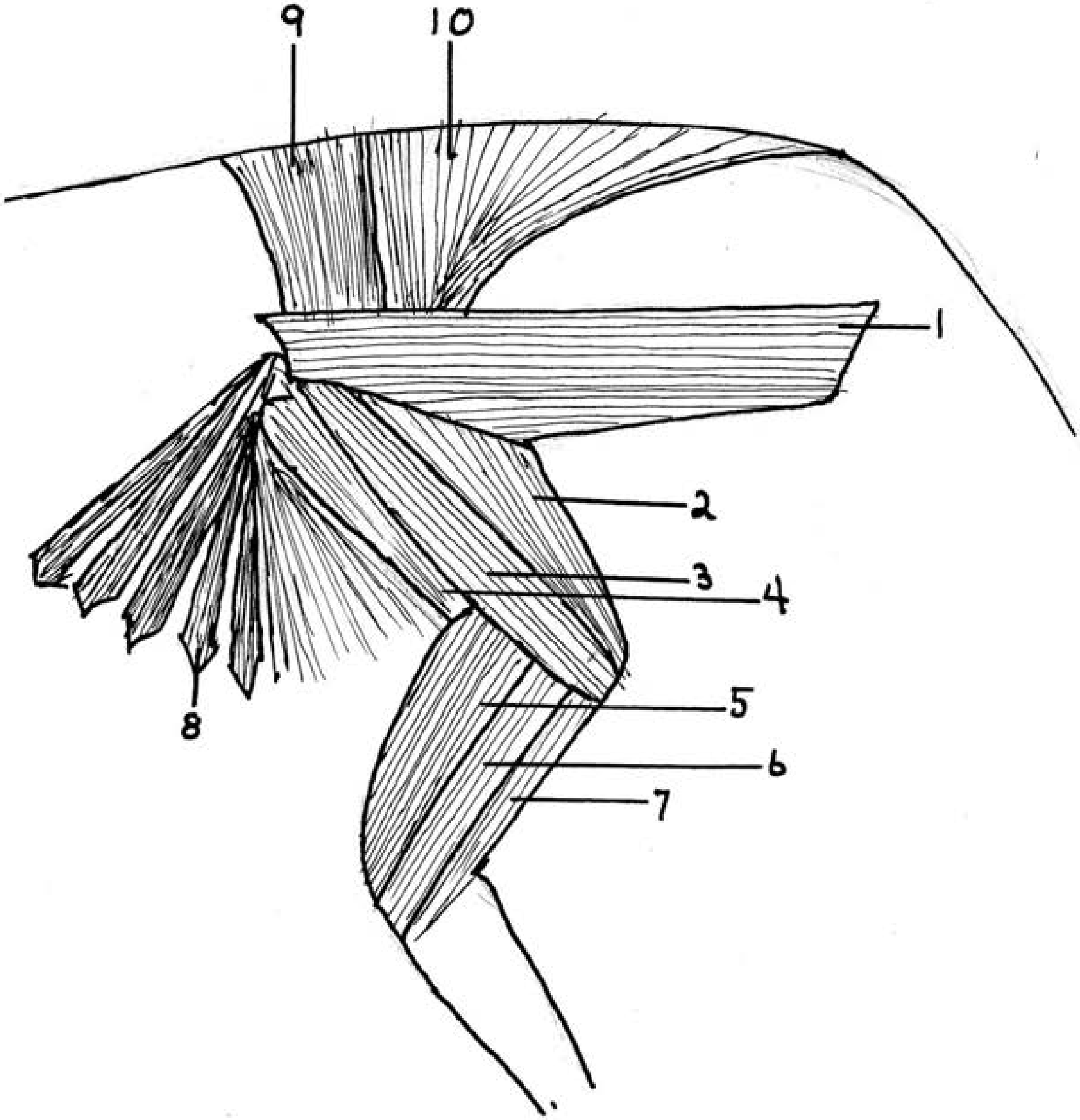


FIRST LAYER OF BODY MUSCLES

1. Acromiotrapezius
2. Clavotrapezius
3. Atlantoscapularis
4. Spinodeltoideus
5. Biceps brachii
6. Triceps lateralis
7. Triceps longus
8. Latissimus dorsi
9. Spinotrapezius

Hamster III

Figure 4

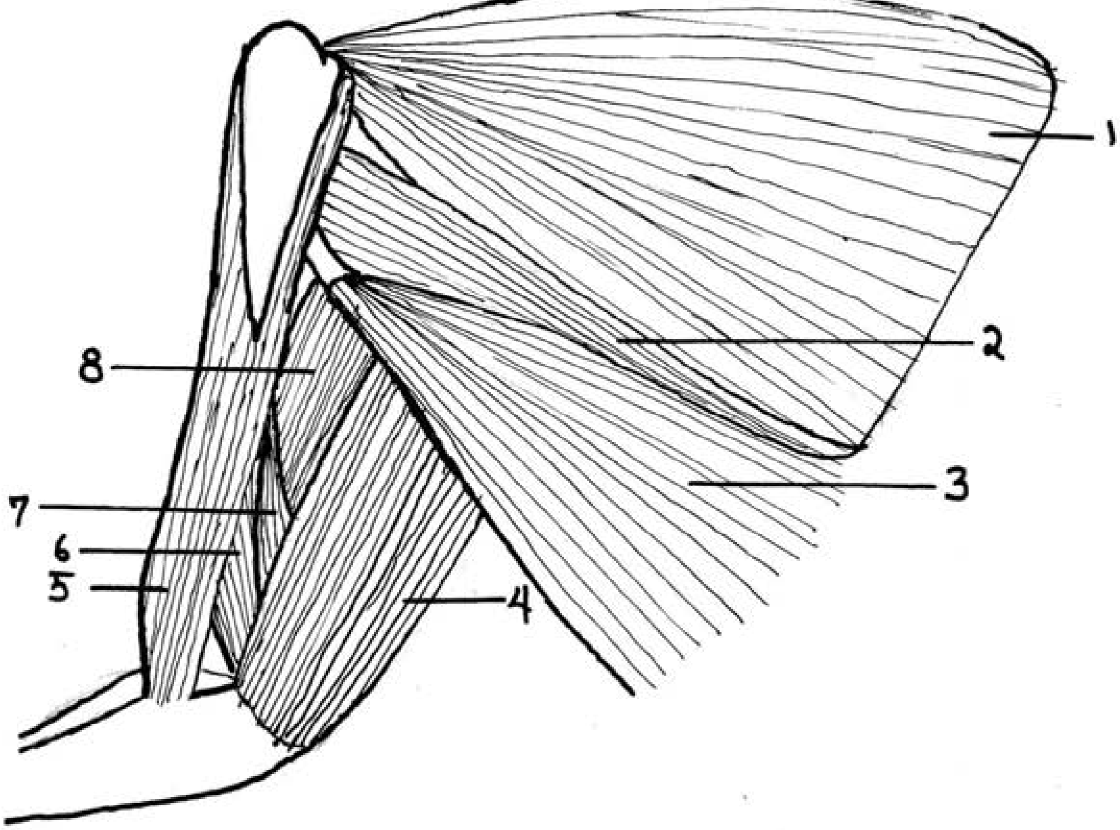


SECOND LAYER OF BODY MUSCLES

1. Occipitoscapularis
2. Supraspinatus
3. Infraspinatus
4. Teres major
5. Triceps longus
6. Triceps lateralis
7. Biceps brachii
8. Serratus magnus
9. Rhomboideus posticus
10. Rhomboideus anticus

Hamster IV

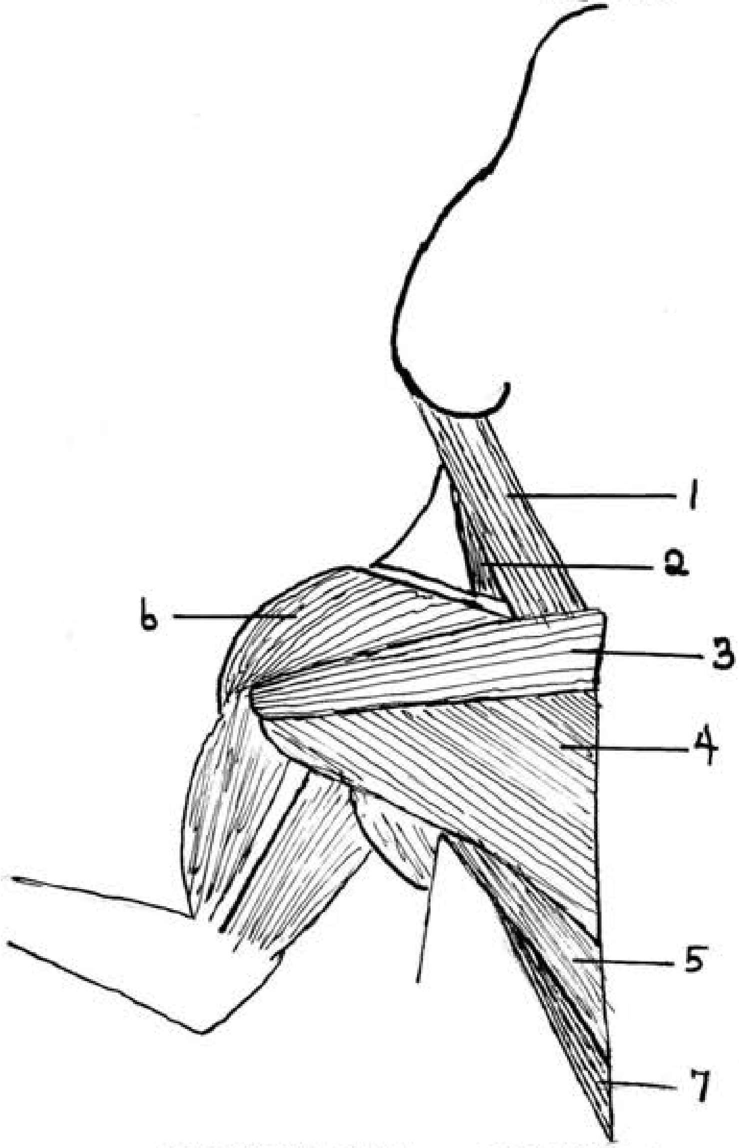
Figure 5



MEDIAL SURFACE OF SCAPULA

1. Subscapularis
2. Teres major
3. Latissimus dorsi
4. Epitrochlearis
5. Biceps brachii
6. Brachialis
7. Triceps medialis
8. Triceps longus

Figure 6



PECTORAL MUSCLES

1. Sternomastoideus

2. Cleidomastoideus

3. Pectoralis (superficial)

4. Pectoralis (second portion)

5. Pectoralis (deeper)

6. Acromiodeltoideus

7. Pectoralis (abdominal)

Hamster VI

BIBLIOGRAPHY

BENSLEY, B. A. 1938, (6th ed.). Practical Anatomy of the Rabbit. Philadelphia: P. Blakiston's Sons & Co., Inc.

GREENE, E. C. 1935. Anatomy of the Rat. Trans. Amer. Phil. Soc., 27.

GUYER, M. F. 1936. Animal Micrology: Practical exercies in zoological microtechnique. Chicago.

HOLLINGER, Charles D. 1916. Anatomical adaptations in the thoracic limb of the California pocket gopher and other rodents. Univ. Cali. Publ. in Zool. Vol. 13, No. 12, pp. 447-494, pl. 38-39, 20 text figs.

HOWELL, A.B. 1926. Anatomy of the Wood Rat. Amer. Soc. Mamm. Monog., 1.

______________.1932. The saltatorial rodent Dipodomys: The functional and comparative anatomy of its muscular and osseus systems. Proc. Amer. Acad. Arts & Sciences. Vol. 67, No. 10.

______________.1937. Morphogenesis of the shoulder architecture. Part VI. Therian Mammalia. Quart. Rev. Biol., Vol. 12, No. 4, pp. 440-463.

LANGWORTHY, O. R. 1925. A morphological study of the panniculus carnosus and its genetical relationship to the pectoral musculature in Rodents. Amer. Jour. Anat., Vol. 35, pp. 283-302.

PARSONS, F. G. 1894. On the myology of the sciuromorphone and hystricomorphone rodents. Proc. Zool. Soc. London, pp. 251-296.

______________.1896. An account of the myology of the Myomorpha, together with a comparison of the muscles of the various suborders of rodents. Proc. Zool. Soc. London, pp. 159-192.

PRIDDY, RALPH B. & BRODIE, ARNOLD F. 1948. Facial musculature, nerves and blood vessels of the hamster in relation to the cheek pouch. J. Morph., Vol. 83, No. 2, pp. 149-180.

REIGHARD & JENNINGS. 1929. Anatomy of the cat. New York: Henry Holt and Company.

WATERHOUSE, G.A. 1839. Description of a new species of hamster (Cricetus auratus). Proc. Zool. Soc. London, Part 7, pp. 57-58.

ZUCHERHANDLE - TANDLER. 1910. Zur Anatomie und Morphologie der Musculi pectorales. Sitzungsberichte der Kaiserlicken Akademie der Wissenschaften, Wein, Bd. 119, S. 467-558.