# VIII. *The Myology of the Cheiroptera.* *By* Alexander Macalister, *A.B., M.B. Dubl., Professor of Zoology in the University of Dublin.* *Communicated by Dr.* Sharpey, *Sec. R.S.*

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The aberrant forms and remarkable habits of the animals composing this order, so divergent from the general mammalian type, render the study of their myology a subject of the deepest anatomical interest; and yet it is singular how little attention has hitherto been directed to its investigation. Thus in the article "Cheiroptera" in the 'Cyclopædia of Anatomy and Physiology,' the muscular system is passed over unnoticed; and in another standard work, Professor Owen's 'Comparative Anatomy of Vertebrates,' the only fact noticed regarding the muscles of the Bats is their deep red colour (vol. iii. p. 1). No extensive series of observations has hitherto been made on this subject; a few species only have been dissected with care, and these dissections have not even been compared with each other. Cuvier, Meckel, Kolenati, Humphry, and Aeby are among the only authors who have published records of their researches, and not more than four or five species have been made the subjects of description.

On examining some of the store jars in the Museum of the Dublin University, I found some specimens of Bats which proved on examination to be in very good dissectable condition. During the past summer I made a very careful series of dissections of these, and have from them compiled the present Monograph. The number of perfectly new and remarkable facts which have, in the course of my examinations, been observed and recorded, will, I think, fully justify me in publishing a detailed account of my dissections.

The small size of some of these animals rendered the dissection a matter of difficulty, as in many cases I was obliged to use a simple dissecting-microscope. For the same reason I was not able to use the balance with any degree of comfort, as a means of comparing the relative development of muscles in different species; I was, indeed, compelled to give up the use of this aid to investigation, as, from the small sizes and the necessary difficulty in raising entire muscles with the degree of absolute perfection requisite in the comparison of such small weights as grains or fractions of grains, the work became almost hopelessly tedious; and thus I have very little additional light to throw upon this interesting subject, whose study has been begun by Professor Aeby in Basel and Professor Haughton in Dublin.

The species referred to in this paper are the following:—of the Pteropidæ, *Pteropus edulis*, *medius*, and *Edwardsii*, *Macroglossus minimus*, *Eleutherura marginata*, *Cephalotes Pallasii*, *Cynonycteris amplexicaudatus*; of the Rhinolophidæ, *Rhinolophus ferrum-*



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*equinum*, *diadema*, and *speoris*, *Megaderma lyra*; of the Phyllostomidæ, *Artibeus jamaicensis* and *Vampyrops vittatus*; of the Vespertilionidæ, *Vespertilio murinus*, *Vesperugo pipistrellus*, *Scotophilus hesperus*, *Noctulina altivolans*, *Plecotus auritus*, *Synotus barbastellus*. These nineteen species will be seen to represent fully the variety of forms included in the order. For purposes of comparison I have also dissected *Pteromys volans* and *Galeopithecus*.

As might be expected, a strong family likeness pervades the entire series; the differences are chiefly slight, though often suggestive, varieties of detail.

### *Cutaneous Muscles.*

These do not form in any species a continuous sheet or panniculus, but consist of separated bands or slips in several regions, the principal of which are the following:—

1. Platysma myoides superior (Plate XIII. fig. 4, *b*), which arises from the ramus of the mandible, from the integument over it, and from the angle of the mouth, usually continuous with the depressor anguli oris; passing backwards and downwards it is inserted into the anterior margin of the occipito-pollicalis (to be afterwards described), to which, however, it lies superficial. This muscle is large and strong in *Eleutherura*, *Macroglossus*, and *Pteropus*, weaker in *Cephalotes* and the Phyllostomidæ; lies distinctly superficial to the occipito-pollicalis in the last named; and in the species of *Vespertilio*, *Vesperugo*, and *Scotophilus* it scarcely seems to be connected to it: it is very feeble in *Plecotus* and *Megaderma*. This muscle is the representative of the ordinary platysma of Man and the Chimpanzee; it is figured as the cervico-fascien by Cuvier and Laurillard in *Pteropus*, and is described as the first part of the platysma by Professor Humphry (Journal of Anatomy and Physiology, vol. iii. p. 299, 1869).

2. Platysma myoides medius (Plate XIII. fig. 4, *c*) is a band of very variable strength, well marked in *Cephalotes*, *Pteropus*, and *Eleutherura*, feeble in *Macroglossus*, and absent in *Vampyrops* and *Artibeus*; it arises from the middle line of the neck for its lower half, in front, passes outwards and backwards over the sterno-cleido-mastoid to be inserted with the last. In the Pteropidæ it is not connected to the last described except at its insertion, but in *Plecotus* they form a continuous very feeble sheet; and the same is the case in the Rhinolophidæ, in which it is extremely thin. In *Cephalotes* and *Eleutherura* the muscles of both sides are continuous in the middle line, and form a strong, thick, red mesial band passing from shoulder to shoulder above the clavicles. This is the third part of the platysma of Professor Humphry (*loc. cit.*).

3. Platysma myoides inferior (Plate XIII. fig. 4, *d*) arises from the integument over the middle of the sternum, passes upwards and outwards to be inserted in common with the upper and middle platysmata. In *Pteropus* it arises opposite the lower part of the sternum; in *Cephalotes* it is narrower and arises higher up. In this genus its fibres are not so oblique as those of the pectoral, and in their course they strongly remind one of the rectus sternalis in some of its forms, thus offering some shadow at least of evidence in favour of the theory put forward and supported by Wilde, Hallet, and Turner, that

this muscle is of the nature of platysma. I have not been able, in any species of the Vespertilionidæ, to demonstrate any connexion between this muscle and the occipito-pollicalis; in these it seems to end in the integument of the top of the shoulder; it is very narrow in *Vampyrops vittatus*, and is similar in its arrangement in *Artibeus*. In all cases its origin was purely cutaneous, and in none had it any connexion with the sternal carina, as was found in *Pteropus Edwardsii* by Professor HUMPHRY (*l. c.* p. 299).

4. In *Cephalotes Pallasii* a thin nuchal band of platysma existed (Plate XV. fig. 2, *f*), passing from the mesial line of the lower part of the back of the neck to join the occipito-pollicalis. I have not detected a similar band in any other species except in *Pteropus edulis*, in which it was very large and extended up to the occiput, covering, but quite separate from, the occipito-pollicalis.

5. Dorsi patagialis (Plate XIII. fig. 1, *b*).—This name I would suggest for a part of the panniculus which I have found in all the species as a fine triangular muscle arising from the integument in the mesial line of the back opposite the lowest dorsal and uppermost lumbar vertebræ, and passing upwards and outwards to the axilla, where it was inserted into the skin of the plagiopatagium*; it lay superficial to the latissimus dorsi, from which it is separated by the superficial dorsal fascia. In *Artibeus* and *Vampyrops* this is strong and red; it is also large in *Noctulina* and the Pipistrelle, in the former of which a slip of it rises to the coracoid process, into the internal edge of which it is inserted. In *Pteropus* it is especially large, particularly in *Pt. edulis*. In *Megaderma lyra* a slip of it runs into the lower margin of the teres major, and another was inserted into the humerus at its upper point of trisection. In *Eleutherura* this muscle coexists with a separate coraco-cutaneous muscle, and is inserted into the skin of the axilla. Neither HUMPHRY nor CUVIER make any reference to this muscle; the former merely mentions in general terms the existence of a few fibres in this locality.

6. Coraco-cutaneus (HUMPHRY) I found as a separate muscle in *Eleutherura*, arising from the coracoid process internal and anterior to the coraco-brachialis, from which it is separated by the brachial plexus; crossing the axillary artery this muscle is inserted into the skin of the axilla. In *Noctulina altivolans* a slip of this muscle exists as an offshoot from the dorsi patagialis, as above described, crossing the brachial plexus. In *Pteropus Edwardsii* and *medius*, as described by Professor HUMPHRY, it is distinct and extends in the plagiopatagium to the lower margin of that fold. Several fibres run parallel to this band which have no bony attachment. Of the same nature as the coraco-cutaneous is the humero-cutaneous muscle which exists in *Noctulina*, arising from the inner border of the humerus three lines above the elbow-joint, passing downwards to be

* To avoid periphrasis, I will use the names recommended by KOLENATI for the different parts of the wing-membranes:—*propatagium* being the part in front of the elbow; *plagiopatagium* that from the extensor aspect of the fore limb to the hinder limb and extending to the little finger; *uropatagium* that between the hinder limbs, including the tail; *epiblema* the membrane attached to the spur; *dactylopatagium brevis* the web between the thumb-root and the index, *d. minus* between index and middle, *d. longus* between middle and ring, *d. latus* between ring and little fingers.

lost in the plagiopatagium; it is a very slender muscle-bundle in this animal, and cannot be traced for more than half an inch; it overlies the pronator teres. In *Cephalotes* this also exists, and it makes a conspicuous ridge, as may be seen in ST.-HILAIRE'S figure of this species (Annales du Muséum d'Histoire Naturelle, tom. xv. pl. 7). I was not able to make out accurately in this species whether any fibres came from the biceps or no, as Professor HUMPHRY has so well described in *Pteropus*; certainly the largest part of its fibres arise from the humerus.

7. Cutaneo-pubic (HUMPHRY) I could only separate in the larger species as an expansion of fine muscular fibres from the neighbourhood of the pubes; these ascended and passed backwards in a narrow stream, which ended over the great pectoral at its shoulder end by being attached to the skin. I could only find it in the Phyllostomine and Pteropine Bats and in the Noctule. I could not trace it to a bony attachment, but Professor HUMPHRY has traced it to the fore part of the pelvis. The same anatomist traced in *Pteropus* one fascicle of the muscle to the lower margin of the plagiopatagium.

8. Femoro-cutaneus (HUMPHRY) was only found in the *Pteropi*, *Macroglossus*, and *Artibeus*, arising from the tibial side of the thigh (in my specimen not so low down or so purely from the bone as Professor HUMPHRY describes it to have been in his *Pt. Edwardsii*); passing in a radiating manner upwards and inwards, it is inserted into the integument of the middle line of the back, over the gluteal muscles, and as high as the middle of the lumbar region.

9. Ischio-cutaneus (Plate XIII. fig. 1, *e*), thin and band-like, I found in *Eleutherura marginata* passing in the uropatagium from the ischium to the integument over the calcaneum and dorsum of the foot. Professor HUMPHRY found the same in the *Pt. Edwardsii*. It is possible that this may be the representative of the biceps flexor cruris diminished to a rudiment. I did not find it in any other species.

Other cutaneous fibres here and there were found in the patagial membranes of other species. Professor KOLENATI has found in some species one of these fascicles between the pectoralis major and the serratus magnus, and inserted into the plagiopatagium; this he calls the corrugator plagiopatagii (Flughautrunzler). In the *Myotus murinus* he figures this (Allgemeine dutsche naturhistorische Zeitung, iii. Band, 1ste Heft, p. 10, Taf. III. *a**). I have not, however, been able to make out, in any species except *Noctulina altivolans*, any muscular band of sufficient size to merit a distinct name in this position. Single bands of fibres do run in this and other directions in the membrane, but they are not worthy of distinct names.

10. At the close of the muscles of this group we may place one of the most remarkable of the muscles found in the organization of the Bat, the occipito-pollicalis of KOLENATI (Plate XIII. figs. 1, 2, 4 & 5, *a*, Plate XV. figs. 1, *q*, & 2, *c*), although its claim to be regarded as a muscle of this group rests on a very slender foundation. This muscle arises from the superior curved line on the occipital bone for a varying extent; in *Cephalotes Pallasii* it extends for nearly the whole length of the ridge, in *Noctulina* it is attached to its outer third, in *Eleutherura* to its outer fifth, in *Artibeus* to the

middle third, in *Pteropus* and *Macroglossus* to the inner half, in *Rhinolophus diadema*, *speoris*, and *ferrum-equinum* to the outer half or third; it is very small in the *Megaderma*: the fibres pass outwards from this origin, extend along the free edge of the propatagium to be inserted into the base of the terminal phalanx of the pollex. The muscular fibres are deeper in colour than those of the rest of the platysma, and vary in the different species in the distance to which they extend. In *Vespertilio murinus*, *Synotus barbastellus*, *Macroglossus*, and *Plecotus* they continue for two thirds the length of the entire course; in the Phyllostomine Bats and *Pteropus* nearly one half is muscular; in all the muscle ends in a highly elastic cord, which continues on nearly to the insertion. A short distance above the thumb, a few muscular fibres are superadded to this. Professor HUMPHRY found in his specimen of *Pteropus Edwardsii* that the whole cord resolved itself into a second fleshy belly; in *Cynonycteris* it had a large inferior fleshy belly; in *Pteropus edulis* its origin was under cover of the nuchopatagial muscle. In all, immediately on the cessation of the secondary muscular fibres, the cord ceases to be elastic and becomes an ordinary tendon.

At its commencement in *Cephalotes* this muscle receives a few fibres from the occipito-frontalis, and on the left side of the specimen dissected a muscular band from this muscle passed to the back of the concha auriculæ (Plate XV. fig. 2, *e*). In the *Eleutherura* this muscle and the occipito-frontal are even more closely connected. In *Rhinolophus diadema* the muscle arises under cover of the retrahens aurem, and its fleshy fibres do not continue beyond the shoulder. At first the glandular and fatty masses associated with the thymus separate it from the cervical trapezius and from the platysma. Its fibres are perfectly free from those of any muscle at first, until it reaches the middle of the shoulder, where the superior middle and inferior parts of the platysma are inserted into it. The nature of this muscle has been the subject of difference of opinion. Professor KOLENATI figures it as a special muscle under the name which I have adopted (Sitzungsberichte der Königlich. böhmischen Gesellschaft der Wissenschaft, 1847, and the Allgemeine deutsche naturhist. Zeitung, Dresden, iii. Band, 1 Heft, p. 9, 1857); he also calls it extensor propatagii, or *Hinterhaupts-Daumenmuskel.* CUVIER and LAURILLARD figure it as the dorso-occipitien, and HUMPHRY describes it as the second piece of the platysma. CUVIER (see HUMPHRY, p. 304) supposes it might possibly be a modified part of the trapezius; and MECKEL, in criticising CUVIER'S description of the trapezius in Bats, says, "mais il existe en outre un muscle longitudinal qui est tout-à-fait séparé du trapezius par le thymus, ce muscle prend naissance à la crête occipitale, se porte en bas et en dehors à l'apophyse acromien et au grand pectoral avec lequel il s'unit antérieurement. Cette disposition est la première trace d'une faible séparation de la partie antérieure du trapèze" (Traité d'Anat. Comp. traduit par RIESTER et SANSON, vol. vi. p. 219). MECKEL'S failure in the tracing of this muscle he redeems subsequently in speaking of the muscles of the pollex; it is plain, however, that in both places he is speaking of different aspects of the same muscle.

I think we have sufficient reason to coincide with the theory thus proposed bb MECKEL,

that this muscle is the modified occipital trapezius, because:—1st, it is supplied by the spinal accessory nerve, as I have been able to demonstrate in *Eleutherura* and *Cephalotes*, as well as in *Megaderma*; this is the source from which the occipital trapezius draws its nervous supply in Man; had it been platysmal it would have been supplied by the branches of the cervical plexus; 2ndly, it has a more definite origin than any part of the panniculus; 3rdly, the spot of its origin is exactly that from which the trapezius should arise; 4thly, it is redder than the rest of the superficial muscles; 5thly, it is analogous in function to the tensor plicæ alaris of the bird, which is the modified acromial deltoid, retaining its origin and altered in its insertion; this seems to be a similarly modified occipital trapezius; 6thly, there is no trace of any other occipital trapezius, and the muscle is always highly developed. Against this view is its arrangement in *Cephalotes* and *Eleutherura*, in which it is actually joined to the cutaneous muscles at its origin. The superadded muscular fibres in the forearm may represent an accessory palmaris, a palmaris brevis, or a flexor digitorum sublimis.

The uses of these muscles are very obvious; the occipito-pollicalis raises and abducts the thumb and makes tense the dactylopatagium brevis. If the triceps cooperate with it, it makes tense the propatagium; the three parts of the platysma cooperate with it and assist it. The other muscular bands either contract the wing-membrane or move the skin. As a general rule the disposition of the cutaneous muscles will be seen to resemble closely the arrangement of the panniculus in the higher Carnivora.

### *Facial Muscles.*

This group of muscles is very well developed among the Bats, and though paler than the body- and limb-muscles, yet they are redder than usual.

The occipito-frontalis (Plate XIII. figs. 2, *d*, & 6, *c*, *d*) in all is quadrigastric, the occipital bellies being quadrilateral, parallel, and close together; this muscle arises from the inner third or half of the superior occipital line. In *Plecotus* the bellies are very short and thick, in *Cephalotes* they are thin and weak; these soon end in the epicranial aponeurosis, from which the anterior bellies spring. In *Plecotus* the aponeurosis begins on the level of the base of the ear, and the frontal bellies are inserted into the integument of the forehead and into the procerus nasi; the anterior bellies are confluent in *Noctulina*, as well as in the *Rhinolophus diadema* and *speoris*, and are barely separable in *Vampyrops* and *Artibeus*, in both of which the posterior bellies have a wide origin. In these also the epicranial aponeurosis is narrow, not exceeding in its length one half of the width of the ear-cartilage; the frontal bellies are enormous in *Cephalotes*, very small in *Megaderma*, moderate in the Pteropidæ.

The size of the ear-muscles, though in general they bear some proportion to the development of the auricle, cannot be said to obey any regular law; for while in *Plecotus* and *Synotus* they are larger than in *Vespertilio*, *Scotophilus*, or the Pipistrelle, yet in *Rhinolophus* and *Eleutherura* they are nearly as large as in *Megaderma lyra*. The extrinsic muscles are the usual three.

1. Retrahens aurem (Plate XIII. fig. 7, *b*) in *Plecotus* is strong and prominent, arising from the occipital line, passes outwards to be inserted into the back of the concha; a few fibres join the muscle of one side to its fellow of the opposite across the mesial line. In *Synotus* its arrangement is similar; in *Vespertilio*, *Vesperugo*, and *Noctulina* it is thinner and wider, and is attached to the outer part of the occipital bone. In *Pteropus* and *Macroglossus* it is also thin, wide, and triangular. In *Vampyrops* it is double (Plate XIII. fig. 6, *a*, *b*), the lower muscle starting from the occipital protuberance, the upper from the curved ridge external to the occipito-pollicalis. In *Cephalotes* it is small and thick; on the left side in my specimen a band came from the occipito-pollicalis to join this muscle, lying superficial to the sterno-cleido-mastoid. In *Megaderma* the retrahens consists of three slips (Plate XIII. fig. 2, *b*, *c*), arising in common with the occipito-frontalis, of which the middle is the longest and the inferior the shortest. In *Myotus* it is still further fasciculated; Kolenati found it in five bundles.

2. Attollens aurem (Plate XIII. fig. 6, *c*) in *Vampyrops* and *Artibeus* is wide and thin; most of its fibres run downwards and forwards; it arises from the epicranial aponeurosis. In *Megaderma* it is wider and thicker, very large in *Plecotus*, and attached from the occipital curved line to the anterior margin of the epicranial aponeurosis; not quite so extensive in the other Vespertilionine Bats. In *Cephalotes* it arises from the mesial line of the scalp, overlying the epicranial aponeurosis (Plate XV. fig. 1, *k*).

3. Attrahens aurem (Plate XIII. fig. 5, *f*) is very large in *Megaderma*, and arises from the supraorbital ridge as well as from the zygomatic arch; it is inserted into the anterior surface of the concha and tragus; in *Plecotus* and *Synotus* it is small and thick. In *Noctulina altivolans* it consists of two parts, one normal from the zygomatic arch, the other a transverse band on the forehead passing from the one ear to the other above the supraorbital ridges, and over the anterior bellies of the occipito-frontales. In *Vampyrops* the muscle is strong and its lower border rounded. In *Cynonycteris* it is single and much weaker, and it is moderate in development. In *Artibeus jamaicensis*, in *Pteropus*, and the Kiodote (*Macroglossus minimus*) it consists of a thin sheet of muscle overlying and attached to the temporal aponeurosis (Plate XIII. fig. 3, *e*). In *Cephalotes* its origin is from the zygomatic process of the temporal bone under the zygomatic muscle; it passes upwards and backwards to the ear, forming a strong band of fibres.

In *Plecotus* Kolenati has found a special depressor tragi passing from the concha to the tragus, which it depresses; this corresponds to the tragicus of the human ear; this exists in the Horseshoe Bats and in *Megaderma lyra*, but I found it in no others.

The nose has one large pair of muscles in every species, the procerus nasi (Plate XIII. fig. 6, *e*) (pyramidalis would be a misnomer in every case); this varies in size, being small and indistinctly joined to the frontalis in *Plecotus*, larger in the Barbastelle (*Synotus*), inseparable from the frontalis and small in *Megaderma*, enormously large and thick and with a special frontal origin in *Rhinolophus diadema*, *speoris*, *ferrum-equinum*, and *hipposideros*, also large, but with no separate origin, in *Cephalotes*. In *Vampyrops vittatus* it is likewise large, and has a special bony attachment. In *Artibeus* it is

inserted into the base of the nose-leaf, and in *Cynonycteris* is exceedingly feeble in its development.

In *Noctulina altivolans* I found two small muscular bands which represented the dilator naris, anterior and posterior; I have not found them in any other Vespertilionine or Pteropine species. In the nose-leaf of *Artibeus* the same were present, but were much larger, passing from the integument of the side of the face to the nose-leaf; in that of *Megaderma* these were much more feeble.

In *Rhinolophus speoris* the first-named pair of nasal muscles are on either side of the pouch, and thus can constrict it.

The eye-muscles are also very simple; the orbicularispal pebrarum (Plate XIII. fig. 3, *d*, & 5, *h*) is a single muscular ring attached to a tendo-oculi, and does not present any variation in any of the species. In *Vampyrops* a few fibres from its upper surface pass upwards and backwards into the anterior belly of the occipito-frontalis, making a sort of corrugator supercilii (Plate XIII. fig. 6, *f*); an arrangement like this also exists in *Megaderma*, but I did not find it in any of the others. No other external eye-muscles were traced.

The muscles of the mouth are usually well developed; the orbicularis in all is a single muscular ring into which the other muscles are inserted; zygomaticus minor I only found in *Cephalotes* (Plate XV. fig. 1, *g*) as a small fascicle above the major from the zygoma to the angle of the mouth.

The zygomaticus major in *Vampyrops* (Plate XIII. fig. 6, *j*) exists as a wide band from the zygomatic arch to the angle of the mouth; in almost all the other species, however, it existed as an auriculo-angular muscle, passing from the front of the ear to the angle of the mouth; this is the case in the Noctule, Pipistrelle, *Cephalotes* (Plate XV. fig. 1, *h*), *Megaderma* (Plate XIII. fig. 5, *e*), and others. In *Macroglossus* (Plate XIII. fig. 3, *h*) and *Pteropus* it is a true zygomatic with no ear-connexion.

A levator anguli oris (Plate XIII. figs. 3, *f*, 5, *o*, 6, *i*) is present in all, arising from the maxilla in front of and beneath the infraorbital ridge; in *Macroglossus* this joins the zygomaticus. A depressor anguli oris and depressor labii inferioris combined exist in the lower lip, arising from the mandible and inserted into the orbicularis (Plate XIII. figs. 3, *j*, 5, *l*, 6, *m*).

Levator labii superioris alæque nasi in *Megaderma* (Plate XIII. fig. 5, *i*, *j*) is a remarkable and complex muscle, consisting of two slips crossing each other, the more superficial passing from above and in front of the inner angle of the eye to the upper lip, the deeper arising external and a little inferior to the former, and passing more horizontally to be inserted into the ala of the nose and the basal lobes of the leaf. This muscle in *Vampyrops* is represented by a single band (Plate XIII. fig. 6, *h*), starting from the inner side of the orbit and nasal bone. In the Pteropine Bats this muscle is thin, and has no nasal attachment (Plate XV. fig. 1, *c*).

The muscles of mastication are very variable in degree of development. The temporal is small in *Plecotus*, larger in *Synotus*, still larger in *Noctulina*, and proportionally largest in *Pteropus edulis*. The masseters are bilaminar in all, proportionally largest in

*Pt. Edwardsii*, then in *Noctulina*, and smallest proportionally in *Cynonycteris*. The buccinator is weakest in *Pteropus*, and proportionally strongest in *Myotus* (*Vespertilio*) *murinus*. The pterygoids, especially the externals, are particularly small in all the species.

### *Muscles of the Neck.*

On raising the integument of the neck the first structures exposed are the several parts of the platysma already described, then several large glandular and fatty masses, connected with the large thymus of these animals. The salivary glands are very large in the frugivorous Bats, especially the parotid, which extends into the anterior cervical triangle; the submaxillary, though smaller, yet is a large gland, and much rounder and more definite than the former. Below these the following muscles are brought into view:—Sterno-mastoid, in *Plecotus* and the other Vespertilionine Bats, as well as in *Megaderma* (Plate XIII. fig. 5, *c*) and *Pteropus*, is a large single indivisible muscle arising from the episternum and sterno-clavicular ligaments, and inserted into the paroccipital and supraoccipital bones; in *Pteropus edulis* it extends as far inward as the occipital protuberance. In the species of *Rhinolophus*, *Pteropus funebris*, *Eleutherura*, and *Macroglossus*, as well as *Cephalotes* (Plate XV. fig. 1, *l*, *m*, *n*), *Vampyrops*, and *Artibeus*, the sterno-mastoid is double, the superficial part being as described above, and covering a deeper band smaller in size, which arises fleshy from the sternum, and is inserted by a narrow tendon into the paroccipital process alone. Both Cuvier and Meckel speak of this muscle as single, and as having no trace of a clavicular origin.

Cleido-mastoid is a muscle whose existence in the Bats has been denied by Cuvier and Meckel; yet it exists and is often moderately strong, as in *Noctulina*: it is usually perfectly separate from the sterno-mastoid, more vertical than which it lies, and in *Vampyrops* the spinal accessory nerve intervenes; it is inserted along with the deep sterno-mastoid into the paroccipital process; it is exceedingly small in *Megaderma*, *Cephalotes*, and *Eleutherura*, larger in *Rhinolophus diadema* and *speoris*; in the Pipistrelle it is only one third the size of the sterno-mastoid; in *Pteropus* it is even less, and its upper third is tendinous, and inserted into the tip of the paroccipital. No trace of a cleido-occipital exists in any of the species examined.

Sterno-hyoid (Plate XIII. fig. 8, *i*) is broad, flat, and thin, passing from the posterior aspect of the sternum to the os hyoides. In my specimen of *Noctulina* it was united to the omo-hyoid in a manner to be described hereafter. A tendinous inscription exists in most of the Vespertilionine Bats; I found none either in the Pteropine or Phyllostomous species, while in *Rhinolophus* the sterno-hyoid is narrow, and presents nothing remarkable. In *Noctulina* the mylo-hyoid was covered by a layer of longitudinal fibres, constituting a mento-hyoidean muscle. Of the other laryngeal and tongue-muscles there are no facts of sufficient interest to deserve special record. The styloid muscles are large and strong, especially the stylo-glossus, which passes as usual from the stylo-hyal bone to the side of the base of the tongue.

Digastric (Plate XIII. fig. 8, *c*, *d*) in the Vespertilionine Bats is a simple one-bellied depressor of the mandible, extending to the middle third of the ramus, and largest pro-

portionally in *Noctulina*. In the Pteropine Bats it is of very large size, especially in *Cephalotes*; in *Megaderma lyra* and *Pteropus edulis* it shows a very remarkable and interesting feature, namely, a tendinous inscription obliquely crossing it opposite the angle of the jaw. This is very interesting in a morphological point of view, as the muscle is not protracted further forward than usual in these species; it shows that the two bellies of the truly digastric type of depressor of the mandible (such as is found among the Primates and the Rodentia) are represented in this and other orders by the single-bellied muscle, and that it is not simply a homologue of the posterior belly. Thus from the single-bellied muscle of the Carnivora and Cetacea &c., we have the intermediate step of the digastric intersected by an inscription leading us to the truly biventral form in the higher mammals.

The omo-hyoid is a slender and distinctly biventral muscle in the Vespertilionidæ. In the Phyllostomine Bats it is large, and with scarcely any trace of a tendinous intersection. In *Macroglossus* it passes from the suprascapular ligament to the hyoid bone, and, as in the other Pteropine Bats, it is digastric, but its central tendon is very short. In my specimen of *Noctulina* there is a muscular band arising from the middle of the clavicle and joining the sterno-hyoid muscle at a point about midway between the origin and insertion of that muscle; immediately beyond the point of union a tendinous line existed in the combined sterno-hyoid and omo-hyoid muscles; no other omo-hyoid existed in this species, and this arrangement was present on both sides. This method of attachment in the omo-hyoid has hitherto only been known as an anomaly in human anatomy, and as such I have described it (Trans. Royal Irish Academy, vol. xxv. 1871, p. 22).

The three scalenes exist in the Bat as MECKEL has described. The anterior is very small, and in *Vampyrops* ascends to the transverse process of the second cervical vertebra; the medius and posticus are united at their origins, separate at their insertions. MECKEL says they are arranged as in the Carnivora; the posticus does not extend below the fourth rib.

The other deep muscles of the neck, longus colli, longus atlantis, recti capitis antici, major et minor, displayed no points worthy of special notice.

### *Muscles of the Thorax.*

This group of muscles is of deep interest, as its elements are concerned in the action of flying.

Pectoralis major (Plate XV. fig. 1, *s*) is in two parts in all species, but they vary slightly in their degree of separability; it is distinctly cleft in the Pteropine Bats into a clavicular and a sternal muscle, not quite so separable in the Phyllostomidæ, separate at origin but combined at insertion in the *Plecotus*, with little more than a distinct trace of division in *Vesperugo*, and nearly completely severed in *Vespertilio*, *Noctulina*, and *Scotophilus hesperus*. The sternal part is undivided and of enormous size, arising from the whole length of the sternum, except the xiphisternum, from the anterior sterno-clavicular ligaments, and it is inserted into the pectoral crest on the humerus.

This muscle is proportionally largest in the Vampyres, especially in *Artibeus*; is short and thick in *Plecotus* and the Pipistrelle. It has in general, properly speaking, no clavicular origin, as Professor HUMPHRY states; but that author does not notice the origin from the sterno-clavicular ligament and the somewhat kidney-shaped epicoracoid. This enormous muscle is by far the largest in the body of the Bat. In *Megaderma* a few fibres are attached to the sternal end of the clavicle, and the entire muscle is much thinner than in the Vampyres. The degree of separation existing between this muscle and the clavicular deltoid is very variable; they are perfectly distinct in the species of *Rhinolophus*, especially *R. diadema*; in *Eleutherura* they are conjoined; nearly so in the *Pteropus Edwardsii*; quite separate in *Pteropus edulis* and in *Megaderma*. In the Vespertilionidæ, as remarked by MECKEL, they are combined. In my specimen of *Pteropus edulis*, which was 36 inches in expanse of wing, this muscle weighed an ounce and one tenth.

The second part of the great pectoral, or the pars clavicularis, is variable in size and separateness, completely covered by the sternal part and small in *Cephalotes*; it arises from the anterior sterno-clavicular ligament and the inner half of the under border of the clavicle; it is inserted above the sternal pectoral into the pectoral crest; it lies on the costo-coracoid membrane and the coracoid process. In *Vampyrops* it is, at its commencement, completely under cover of the sternal part, but at its insertion it is the more superficial of the two. In *Macroglossus* and *Pteropus* this portion, though in its course and termination on a plane posterior to the sternal part, is less covered at its origin, and passes over the coracoid process. In these it arises from nearly the whole length of the clavicle (two thirds in *Pteropus medius*, one third in *Edwardsii*, Humphry, even less in *Pteropus edulis*); its lower surface is flat and fleshy where it lies on the coracoid, from which it is separated by loose areolar tissue; but no bursa intervenes, and the relation of the parts in nowise partakes of the nature of a pulley. This portion in the *Plecotus* overlaps the sternal part for one half, and the same is the case in *Vespertilio*. In *Megaderma* it is more distinctly separate than in any other species, the anterior cutaneous nerve intervening between it and the pars sternalis; in this species it has much the appearance of the human anomaly pectoralis minimus described by Professor WENZEL GRUBER, of St. Petersburg; it arises from the clavicle, sterno-clavicular ligament, and from the cartilage of the first rib; the insertion is by a special round tendon into the pectoral crest of the humerus.

The nature of this second part of the great pectoral has been a subject of difference of opinion. CUVIER, in the 'Leçons Orales,' describes the great pectoral as tripartite, and regards this as its second part. MECKEL describes the great pectoral as consisting of a superficial and two deep portions; the first of these, he says, arises from the sternum and clavicle (my dissections, as noticed above, do not bear out the latter part of the statement; but as he did not separate the clavicular deltoid from the sternal pectoral, he looked on the origin of the latter as part of that of the former), the second part is clavicular, and the third also from the clavicle. In their Plates of *Pteropus*, CUVIER

and LAURILLARD figure this muscle as the petit pectoral; HUMPHRY regards it as a part of the great pectoral, and corrects CUVIER'S error of assigning to it a costal origin. The fact of this muscle and the pars sternalis receiving their nervous supply from the anterior thoracic nerve, a branch of the external cord of the brachial plexus, settles the question of its morphological nature.

Pectoralis minor is absent in every species.

Pectoralis quartus in all is a distinct, well-developed muscle, largest proportionally in *Noctulina*, smallest in the Pipistrelle, and very small in *Scotophilus hesperus*. In general it arises from the superficial fascia of the abdomen opposite the level of the lower margin of the thorax, at the anterior termination of the upper false ribs; in no case did its origin stretch as a separate structure to the pubis, and it invariably was distinctly superficial to the rectus abdominis; and even when I detached artificially a slip of the fascia to make a factitious origin, it lay over and not alongside, or in any sense in common with the rectus, as Professor HUMPHRY describes. In *Cephalotes* its origin is from the middle line of the abdomen at its middle point, and its fleshy fibres overlie those of the rectus, crossing them at a small angle; in this species it passes underneath the pars sternalis of the great pectoral to be inserted into the uppermost point of the pectoral crest of the humerus, immediately inferior to the insertion of the pars clavicularis. In all the species except *Plecotus* it was perfectly detached from the great pectoral, and in that species it was merely connected with it at its insertion. In every other instance the muscle ended in a long tendon, by which it is inserted into the summit of the pectoral crest. In *Pteropus edulis* its origin corresponds to the linea alba, an inch below the ensiform cartilage, and extending down for one fourth of this line.

Its origin is always superficial, and below the great pectoral; but owing to the greater verticality of its fibres it soon sinks under cover of that muscle. In *Pteropus* and its allies the insertion is, as described by Professor HUMPHRY, into the point below the pars clavicularis. In *Vampyrops vittatus* and *Artibeus jamaicensis* it is also below, but not quite in contact with the other muscle. In *Vespertilio* and *Scotophilus* it is behind the pars clavicularis. It is thin and inserted higher up in *Megaderma*. In *Eleutherura* it arises from the middle line of the upper third of the abdomen, also superficial to and separate from the rectus, and it extends even over the ensiform cartilage. This muscle is regarded by CUVIER and LAURILLARD as the portion ventrale of the great pectoral, and by Professor HUMPHRY is considered as probably the representative of the pectoralis minor (*loc. cit.* p. 301). It is, however, a muscle of a different nature, one whose synonyms are numerous, and which has been recognized as a distinct muscle by Professor HUMPHRY in the Orycterope and Seal, under the name of *brachio-lateralis**. In Man it often

* The names given to this muscle in different animals are legion. It has been called humero-abdominalis (KLEIN), abdomino-humeralis (DUGÈS), costo-humeralis (HUXLEY), chondro-epitrochlear (DUVERNOY), brachio-abdominalis (ZENKER), brachio-lateralis (HUMPHRY), portio-abdominalis pectoralis majoris (ECKER). Pectoralis quartus, the name given to it above, was settled on by Professor HAUGHTON and myself as the name by which we should call it.

coexists* with the lesser pectoral as an anomaly; and in one of its conditions it is known as the chondro-epitrochlearis. That it is not pectoralis minor is shown by this fact, and also by the fact that it is supplied by the anterior thoracic nerve from the outer cord of the brachial plexus, not by the middle, which should supply it if it were lesser pectoral.

Cuvier and Meckel describe a muscle passing in the Bat from the three upper ribs to the coracoid process with a broad tendon of insertion; this they call the pectoralis minor. I have not seen the least trace of a muscle like this in the whole course of my dissections, nor has Humphry met with it in his *Pteropus*.

A strong costo-coracoid membrane underlies the pars clavicularis of the great pectoral and covers the subclavius; this is weakest in *Rhinolophus diadema* and *Cephalotes*, strongest in *Macroglossus*. The subclavius (Plate XIII. fig. 13, *a*) beneath it in all passes from the first rib to the clavicle, and has no connexion with any other bones; its origin is tendinous in *Megaderma* and *Plecotus*. This tendon is long in the Pipistrelle; its costal attachment is fleshy and tendinous in *Pteropus*, and is fleshy and from a large extent of the first rib in *Pteropus*, *Cephalotes*, and *Macroglossus*. Its insertion is into the outer half of the under surface of the clavicle, or the outer seven eighths as in *Megaderma*, or two thirds as in *Artibeus*. The muscle is proportionally smallest in *Noctulina*. Its non-extension is interesting, as this is the homologue of the levator humeri of the bird, whose extension to the humerus is of such importance in avian flight, thus indicating the difference between the mechanism of flight in the two series.

Serratus magnus is a double muscle in all the Bats, and consists of an inferior and a superior part; the former arises from a varying number of ribs below the first, eight in *Plecotus*, *Synotus*, *Vespertilio*, and *Noctulina*, with two slips from the second rib in *Vespertilio murinus*, *Vesperugo pipistrellus*, and *Noctulina*, with a single wide slip in *Plecotus* and *Synotus*. In *Macroglossus* it is attached to nine ribs, with only one slip from the second; in *Artibeus* and *Vampyrops* it is attached also to nine; in *Pteropus medius* and *Edwardsii* to eight, or ten, as in *P. edulis*; in *Megaderma* to nine. Meckel describes it as arising from the ribs, except the two last; it is inserted into the inferior and external border of the scapula between the teres major and the subscapularis, sometimes rising nearly halfway along the axillary margin of the scapula, as in *Megaderma*. In *Vampyrops* it has an attachment higher up to the posterior border, and a tendinous sling stretches from this to the main insertion at the lower angle.

Serratus magnus superior arises from the first rib in the Rhinolophidæ, Phyllostomidæ, as well as in *Vesperugo* and *Scotophilus*. In *Noctulina* it arises from the upper three ribs behind the upper border of the serratus inferior; in *Pteropus* it has a second tooth from the second rib; its origin is under the scaleni, and is inserted into the vertebral edge of the scapula at its upper angle under cover of the insertion of the levator anguli scapulæ, from which it is perfectly separate in all the Cheiroptera, even in *Megaderma*, in which the serratus magnus superior arises from the first rib, and from the transverse process of the last cervical vertebræ.

* I figured and described this muscle in *Cebus capucinus*, Proc. Nat. Hist. Soc. Dubl. 1866, pl. 1.

Serratus anticus arises (Plate XV. fig. 1, *u*) from the sternum beneath the pars sternalis of the great pectoral, and overlying the prolonged rectus abdominis is inserted into the first rib below the origin of the subclavius; its sternal origins are as usual tendinous, and its insertion fleshy. In *Vesperugo* it extended as far down as the attachment of the fifth rib-cartilage to the sternum, in *Noctulina* only to the second sterno-chondral articulation; in *Artibeus* it extended to the third: in *Vampyrops* it was divided into two parts, one of which was attached to the sternum opposite the third rib-cartilage and to the second rib-cartilage; the other passed from the sternum to the first rib. In *Pteropus* it is very weak, and extended as far down as the third sterno-chondral joint; it is strong, fleshy, and thick in *Cephalotes* and *Eleutherura*.

The intercostals, infracostals, and transversus thoracis anterior presented no noteworthy features.

*Muscles of the Back.*

The nuchal hollow in all the specimens was filled up by a fatty mass, which in my large *Pt. edulis* was an inch in thickness in the middle; this lay below the occipito-pollicalis, which we have before described as probably the occipital trapezius; on clearing this out, no distinct trace of a ligamentum nuchæ exists.

The second part of the trapezius muscle, or the trapezius dorsalis is large and with a very thick rounded upper border. In *Artibeus* and *Vampyrops* a semidetached upper slip passed from the two lowermost cervical spines to the outer fifth of the clavicle; this is weak, and is the only trace of the cervical trapezius in the entire order. The proper dorsal trapezius is a single muscle in *Pteropus*, *Macroglossus*, *Cephalotes*, *Plecotus*, *Vesperugo*, and *Eleutherura*; it arises from the spines of all the dorsal vertebræ but the two lowest in *Macroglossus*, all but the lowest five in *Cephalotes*, from all in *Plecotus*, not so far down in the Pipistrelle and *Scotophilus*, but I could not ascertain by how many they fell short; it is inserted into the upper margin of the spine of the scapula and acromion process. In *Myotus murinus* it is attached to eleven dorsal spines, as described by Cuvier, Meckel, and Kolenati. In *Pteropus* the fibres extend to the outer fifth of the clavicle; in the Pipistrelle there is also a clavicular fascicle. In *Noctulina* the muscle is double, the superior dorsal trapezius arising from the spines of the vertebræ in the uppermost third of the dorsal region; and these fibres run transversely across to the scapular spine and acromion, making a quadrilateral muscle. The inferior trapezius springs from the spines of the vertebræ in the middle third of the dorsal region; its fibres ascend, and are inserted into the posterior margin of the scapula at the base of the spine; for a short distance before its insertion the muscle becomes tendinous. In *Vampyrops*, *Artibeus*, *Megaderma*, and *Rhinolophus* the trapezius is also cleft (Plate XIII. fig. 9, *f*), and the widest interval exists in the last two of these genera. In *Megaderma* the superior trapezius arises from the three uppermost dorsal spines, the inferior from the lowest four, the intervening space being only occupied by a very thin cellular expansion, through which the fibres of the rhomboid were visible; the inferior portion was inserted by a long tendon into the superior angle of

the scapula; the superior portion sends a few of its fibres to the outer eighth of the clavicle. In *Rhinolophus diadema* and *speoris* the arrangement is the same. In the Vampyres the muscle is divided into an upper and lower part also; the upper from the four superior dorsal spines to the acromion, the lower begins two or three vertebræ below, and extends down to the second from the last dorsal vertebra: this portion is connected to the latissimus dorsi at its origin, and reminds one of the inferior trapezius in the bird. The lowest fibres of this muscle are continued into the posterior marginal fibres of the acromial deltoid, a tendinous inscription marking the line of fusion. An approach to this doubleness exists in the Pipistrelle, in which the central part of a single trapezius is intersected by a tendinous line. In the *Megaderma* I traced the principal part of the spinal accessory distinctly into this muscle, the upper branch of it going, as before mentioned, to the occipito-pollicalis. In all the upper border of trapezius is twice or thrice as thick as the lower.

Rhomboideus (Plate XV. fig. 2, *j*) is a single undivided muscle in all, never prolonged up to the occiput; its fibres do not rise higher than the spine of the first dorsal vertebra, and they extend to the fourth in the Pipistrelle and *Plecotus*, to five in *Myotus*, *Cephalotes*, *Eleutherura*, and *Megaderma*. It is strongest in the *Pteropi*, next in the Phyllostomidæ. Meckel states that it arises from the lowest cervical vertebræ, but this I have not found in any species; its insertion is into the hinder margin of the post-scapula, and in *Megaderma* it extends to the hinder edge of the meso-scapula.

Serratus posticus superior in all is very thin, so thin, indeed, as to be scarcely demonstrable; it is only attached to two ribs in *Myotus*, *Synotus*, and *Plecotus*, to three ribs in *Vampyrops* and *Artibeus*, to the four uppermost, except the first, in *Cephalotes*. Meckel says the superior is much stronger than the inferior; but I found very little difficulty in tracing both in many of the species, and in *Megaderma* the lower is the stronger.

Serratus posticus inferior, still thinner, is only attached to two ribs in the Pipistrelle, to the same number in *Vampyrops*, to five in *Cephalotes*, to three in *Megaderma*, in which it is proportionally strongest.

Splenius (Plate XIII. fig. 9, *a*, & Plate XV. fig. 2, *d*), a single large muscle arising from the five lowermost cervical and one dorsal spines; in all it is undivided and attached to the occiput, as well as to the two or three upper cervical transverse processes. In *Pteropus* it is purely occipital, and has a tendinous insertion.

In *Megaderma lyra* this muscle covers over a rhombo-atloid slip, which passes from the transverse process of the atlas to the spine of the first dorsal vertebra. I did not see this in any other species. This muscle occurs elsewhere as an anomaly in Man.

Complexus in the *Vampyrops* is a thick muscular mass, including in it the complexus proper, trachelo-mastoid, and the biventer cervicis; it presents no intersections. In *Megaderma* and *Pteropus* the biventer is separate, and is strong and straight with a distinct linear transverse inscription; it arises from the spine and transverse processes of the upper dorsal vertebræ (one or two), and is inserted into the occiput. The com-

plexus proper is attached below to the lower two or three cervical transverse processes. MECKEL says these muscles have no inscriptions in the Bats.

Latissimus dorsi in *Macroglossus minimus* and *Cephalotes* arises from the spines of the four lower dorsal vertebræ; in *Pteropus medius* and *Edwardsii* from three; in *Pt. edulis* from four; in *Eleutherura* from the four lower dorsal and two upper lumbar spines; from three dorsal and two lumbar in *Megaderma*. In none has it any costal attachment; the fibres run upwards, outwards, and forwards, to be inserted into the inner bicipital edge of the humerus above the teres major, and directly below the inner tuberosity. CUVIER gives as its origin the two lowest dorsal spines, and mentions its being connected to the trapezius (*loc. cit.* i. p. 276); this is denied by MECKEL (*loc. cit.* p. 267); but nevertheless, as mentioned before (see trapezius), it is true in one genus. In *Noctulina* it occupies the lowest third of the dorsal region, springing from four dorsal spines. In all the species a bursa separates its tendon from that of the teres major. In the Vampyres it has an additional lumbar vertebra in its origin, and gets a slip from the iliac crest; in the Pipistrelle its lumbar origin is very scanty, and only attached to two vertebræ. CUVIER says its tendon is joined to that of the teres major, which arrangement did not exist in a single specimen dissected by me.

The erectores spinæ are very feeble, weaker than in any other group of mammals according to MECKEL. The sacro-lumbalis is only attached to the nine lower ribs in *Megaderma*. In the smaller species these muscles justify CUVIER'S description, by existing as a few tendinous fibres near the spine. Extensores caudæ in the Noctule are long, and pass from the sacrum as usual; there is no separable multifidus spinæ as MECKEL describes. The obliquus superior capitis is very small in *Megaderma*, and lies parallel and internal to the rectus capitis lateralis; the obliquus inferior is equally large, and the rectus capitis posticus major is wide and triangular, with a broad insertion; the rectus posticus minor is small, short, and square. In *Plecotus* the occipitalis major nerve is very large, and sends filaments to ramify on the back of the ear.

The levator anguli scapulæ in all is a separate moderately large muscle; in the Vampyre it consists of two slips one over another; it lies on a plane superficial to the serratus and above the rhomboideus; its origin is from the sixth and seventh cervical transverse processes, and its insertion is into the posterior border of the scapula above the spine. It is single, but with the same attachments in the *Plecotus*, Pipistrelle, and Noctule. In *Cephalotes* it also is attached to the two lowest cervical vertebræ, to the posterior border of the prescapula; and the same is the arrangement in the *Eleutherura* and *Pteropi*. In *Megaderma* it overlies the slip of the serratus magnus superior from the seventh cervical transverse process, from which it is separated by the posterior muscular branch of the brachial plexus passing back to supply the rhomboid.

Levator claviculæ (omo-atlanticus, omo-trachélien, acromio-trachélien, trachelo-acromial, acromio-basilar, cervico-humeral of divers authors) I found in all but *Plecotus*; it arises above the levator anguli scapulæ from the fourth and fifth cervical transverse processes, in *Pteropus* from the second and third (HUMPHRY, p. 304), and is inserted

into the clavicle at its outer fourth, behind the cervical trapezius when that muscle exists; in the Pipistrelle it arises from the fourth alone; in *Pteropus* its fibres run to the outer point of trisection of the clavicle. It is very strong in *Cephalotes*, and sends some fibres to the acromion.

*Muscles of the Upper Extremity.*

The deltoid is divided into three parts in general, which look like perfectly separate muscles; the acromial deltoid (Plate XIII. figs. 9, *c*, 10, *a*) is very distinct, arising from the acromion process of the scapula, and inserted into the upper and outer part of the humerus on the outer side of the pectoral ridge. In *Macroglossus* and *Pteropus* it extends below the pectoral muscle (the same length in *Pt. Edwardsii*, twice as far down in *Pt. edulis*, Humphry). I could not find in any of the species of *Pteropus*, *Eleutherura*, *Cephalotes*, or *Macroglossus* any of the posterior fibres running into the triceps; they are closely applied together, and without careful dissection cannot be separated. In *Plecotus* this muscle is solid and thick, and its insertion is high up; the opposite extreme in the way of length is in *Eleutherura*, in which the muscle extends for one sixth of the humerus below the inferior border of the insertion of the great pectoral. In *Vampyrops* the fibres run from the acromion in a radiating manner, the upper being short and nearly transverse, the lowest being long and oblique. In *Megaderma* its origin extends behind the acromion from the meso-scapula, and its fibres take the same course as in *Vampyrops*; thus its fibres have the same relation to the clavicular deltoid that the scapular deltoid has to it.

The clavicular deltoid is in general, as Meckel describes, inseparable from the great pectoral, and is not absent as Cuvier supposed; it is always separate from the acromial portion: the muscle is partly separated from the pars sternalis of the pectoral in *Eleutherura*, completely separated in *Megaderma* and *Pteropus edulis*, arising from the outer fifth of the clavicle (outer half in *Pt. edulis*); it is inserted over the pectoralis major, and the borders of the muscles are superficially marked out from each other by a vein (the cephalic). In *Pteropus Edwardsii*, Humphry found the deltoid attached to the outer half of the clavicle, internal to the insertion of the trapezius; he also found it blended with the pectoralis major at its insertion (*loc. cit.* p. 305). It is always with the pars sternalis of the pectoral that the clavicular deltoid is fused, not with the pars clavicularis, which lies on a plane deeper.

The scapular deltoid (Plate XIII. figs. 9, *g*, & 10, *d*) is nearly inseparable from the acromial in *Rhinolophus diadema*, at least the contiguous fibres are nearly parallel and closely applied to each other. In general this muscle arises from the margins of the infraspinous fossa, over the infraspinatus muscle, from which it is separated by a thin layer of fascia. In *Macroglossus* it is attached to the posterior half of the lower margin of the scapular spine, as well as to the posterior margin of the postscapula. In *Eleutherura* its fibres are very transverse, chiefly from the hinder margin, and on the same plane with those of the teres major. In the Pipistrelle its outer and upper fibres are

nearly parallel to the posterior border of the acromial deltoid, showing its deltoid nature In *Noctulina altivolans* none of its fibres are meso-scapular; they all arise from the posterior margin. In *Vampyrops* its origin is also posterior. The insertion in all is into the external side of the humerus, below the external tuberosity and under cover of the acromial portion; the insertion is single in *Pteropus* and its allies, except *Pt. edulis*, double in *Vampyrops* and *Artibeus* and *Pt. edulis*; in the two former the two slips of insertion are a considerable distance apart. In *Plecotus*, *Vespertilio*, *Vesperugo*, and *Scotophilus* the insertion is single also. In *Megaderma* a few fibres of the trapezius are continued into its upper border.

In *Megaderma* this muscle is very deltoidean in appearance in the direction of its fibres; it is least so in *Cephalotes*, in which, as in *Noctulina*, no fibres arise from the spine of the scapula.

Professor HUMPHRY considers this muscle as teres minor, CUVIER more properly recognized its deltoidean nature, MECKEL confounded it with the infraspinatus, which he describes as very thick. That it is the scapular deltoid is plain from its position overlying the infraspinatus and its fascial relation, lying between two laminæ of the infraspinous fascia, and from its coexistence with a beautiful little teres minor; indeed the only feature not deltoidean about it is its transverse direction, a condition which gives it great power in rotating and retracting the humerus.

Supraspinatus (Plate XIII. fig. 11, *c*) is a moderately strong muscle, penniform in structure, and placed under a strong fascia, whose upper border is thickened into a very strong suprascapular ligament; it is larger than the infraspinatus in *Pteropus*, smaller in *Cephalotes* and *Megaderma*; the difference between the two, however, is very slight. MECKEL says the infraspinatus is much the larger, because he included the last muscle together with the infraspinatus proper under this head; its tendon crosses the upper part of the joint, and is in contact with the synovial membrane in *Macroglossus*, the capsule being deficient under it.

Infraspinatus (Plate XIII. fig. 12, *h*) is proportionally largest in *Rhinolophus diadema* and *speoris*, being more than twice as large as the supraspinatus. In no species did I find any difficulty in separating it from the supraspinatus, although MECKEL says they are scarcely separable; it is separated from the deltoid by a deep layer of fascia, and a strong spino-glenoid ligament lies between it and the supraspinatus; its tendon is closely applied to the capsule of the shoulder, and is inserted into the greater tuberosity below the last. In *Megaderma* this muscle is elongated and penniform, and overlapped by the teres major.

Teres minor is a beautiful little muscle, whose existence has not been noticed by any anatomist; it lies under cover of the infraspinatus; in *Pteropus edulis* it was half an inch long, and its insertion was a quarter of an inch broad (Plate XIII. fig. 12, *i*); it arises from the axillary costa, as usual, for about a line or a line and a half; its tendon of origin crosses over the triceps longus, becomes fleshy, and is inserted below the infraspinatus into the greater tuberosity; and its insertion is easily distinguished from that of the last

named muscle, as it is fleshy, while that of the infraspinatus is tendinous. It is proportionally largest in *Plecotus* and *Noctulina*, very small, flat, and thin in *Megaderma*; it has a fleshy origin in *Cephalotes*; in *Cynonycteris* it is very short and thick, while it is absent in the Pipistrelle, *Vespertilio murinus*, and *Scotophilus*. MECKEL says this muscle is absent (*loc. cit.* p. 276); I could not determine the nervous supply of this muscle in any of the species.

Teres major is a large muscle and displays nothing remarkable; its tendon is inserted further from the latissimus dorsi than in most animals, being completely below it. It is developed in about equal proportion in all, being about three fourths the size of the combined supra- and infraspinati.

Subscapularis (Plate XIII. fig. 13, *b*) is a remarkable muscle, as probably the largest subscapulars in the animal kingdom are possessed by Bats; the thickness of this muscle is enormous, and it occupies the entire subscapular fossa; it has a few tendinous septa in it, and its tendon is not in contact with the synovial membrane as Professor HUMPHRY has noticed. A separate subscapulo-humeral slip exists in all the larger Pteropine and Phyllostomine Bats (Plate XIII. fig. 13, *c*).

Coraco-brachialis is a small muscle in all; but Mr. WOOD is in error in supposing it to be the true coraco-brachialis brevis (Journal of Anat. and Phys. vol. i. p. 52, 1866). If we limit that name to the muscle whose insertion is above, or connected to the insertion of the teres major and latissimus dorsi, then in none of the Bats examined is there a short coraco-brachialis. It arises from the coracoid process beneath the coracoid head of the biceps; its insertion is into the inner side of the humerus, below the latissimus and teres tendons. In *Plecotus* it is inserted into the upper fifth of the bone; in *Myotus murinus* its insertion is opposite to the middle of that of the deltoideus acromialis. In *Cynonycteris* it is, as in *Cephalotes*, attached to the upper fourth of the humerus. In *Artibeus* it is still shorter, but still plainly not a coraco-brachialis brevis. In none is a long form of the muscle present. In *Synotus barbastellus*, *Vesperugo Kuhlii*, and the Pipistrelle it is the same as in the *V. murinus*. In *Vampyrops* it is slender and much larger, passing much further down the humerus to its insertion, which is opposite the upper part of the middle third of the bone. In *Macroglossus* it is closely connected to the biceps at its origin, and its insertion is into a little more than the upper third of the humerus; it is partly divisible into two parts in this genus, but they both partake of the characters of the coraco-brachialis medius. In no species, even of *Pteropus*, did I find it possessing the connecting fibres to the brachialis anticus described in *Pteropus Edwardsii* by Professor HUMPHRY; it is very short in *Noctulina*. CUVIER says it is absent in the Bats (Leçons Orales, i. p. 277); but MECKEL found it and describes it (Comp. Anat. vol. vi. p. 281). HUMPHRY found it bipartite in *Pteropus*, one part coming from the biceps short head, the other from the coracoid process; these are separated by a plane of cellular tissue as in *Macroglossus*. In *Megaderma* the muscle is single, beneath the coracoid head of the biceps, and it lies on the external cutaneous nerve which lies between it and the bone; the insertion is into the second and third sixths of the humerus.

In *Rhinolophus diadema* the coraco-brachialis is shorter than in any other species. In *Eleutherura* and *Epomophorus* this muscle has its insertion into a tendinous sling, such as that which Professor HENLE figures as the normal method of its insertion in Man (Muskellehre, fig. 86), and it occupies the middle third of the humerus; in this species likewise the origin is separated from the origin of the coraco-cutaneus by the external cutaneous nerve. In *Pteropus edulis* this muscle extends halfway down the arm, is pierced by the external cutaneous, and from its posterior side it gives an origin to the inner head of the triceps.

Biceps flexor cubiti (Plate XIII. fig. 13, *f*) always consists of two heads, which are very separate, at their origins at least; the internal of these arises from the extremity of the coracoid process, the external from the margin of the glenoid cavity at the foot of that process on its outer side: the former of these soon becomes fleshy, forming a wide thick upper fleshy part of the muscle; the latter runs from its origin over the upper part of the humerus as a thick hard strap, and becomes fleshy on a lower level than the former. Professor HUMPHRY remarks that neither can be called truly glenoidal; but the same author has elsewhere remarked that the long head usually springs from that part of the glenoid cavity which belongs to the coracoid process. In *Cephalotes Pallasii* the coracoid tendon passes further than usual before becoming fleshy, and lies in front of the coraco-brachialis; the two bellies in this species likewise are perfectly distinct for their whole extent, and they are inserted into the radius, the coracoid being in front of the other part: in this species the tendon of the long head extends into the shoulder-joint; the belly in connexion with this head is three times the size of the coracoid belly. In *Plecotus* the two parts unite high up, and form a very short and very thick belly, which is very protuberant in the arm under the insertion of the pectoral muscle; this is only one fourth the length of the arm, and its tendon of insertion is twice as long below: in the Pipistrelle there is a similar long tendon. In *Vampyrops* the coracoid head is fleshy above, and becomes sooner tendinous than the glenoid; the upper tendon of the latter is very thick where it passes over the shoulder-joint. In *Macroglossus* the coracoid biceps is one third the size of the glenoid; they are nearly equal in *Vampyrops*; and in *Artibeus* they are similar, but proportionally larger than in the last named.

In *Noctulina* the coracoid is one half the size of the glenoid, and the tendon of insertion is very long. The biceps in all is inserted into the ulnar or inner side of the radius below its tubercle, a bursa lying under the tendon; this tendon is single in *Plecotus*, *Synotus*, *Noctulina*, *Vespertilio*, *Vesperugo*, and *Scotophilus*. In no case did I find any humeral head, or the slightest trace of any fibres from the humerus into the biceps in any of the nineteen specimens dissected. This is remarkable, as MECKEL has described the biceps in the Bat as arising from the coracoid and the humerus, which soon unite (Anat. Comp. vol. vi. p. 290); and Professor HUMPHRY in the female *Pteropus* found some fibres of the brachialis anticus going into the biceps. In *Megaderma lyra* the coracoid head is one third of the glenoid. In *Rhinolophus diadema* the two are separate for their whole length: in the coracoid the belly is one fourth of the arm, and the tendon

three fourths; in the glenoid the tendon is half the length of the arm and the belly half. Except in *Eleutherura* and *Cephalotes* the bursa beneath the long tendon does not open into the shoulder-joint. Professor HUMPHRY describes it correctly in *Pteropus* as lying in a separate bursal canal and being separate to its insertion. Professor AEBY says that in the common Bat the two heads are perfectly fused together (SIEBOLD & KÖLLIKER'S Zeitschrift, x. p. 45). According to this author the biceps is to the brachialis anticus in weight as 30·73 : 1·40.

The brachialis anticus is a very small muscle, so small in *Macroglossus* as to be scarcely detectable; it arises from the external side of the humerus, in front of and above the musculo-spiral nerve and external to the biceps; it passes posterior to that muscle to be inserted into the ulna. A bursa separates its tendon from that of the biceps. MECKEL describes this muscle as long and slender. In *Plecotus* and the others of the Vespertilionidæ it arises from the upper point of trisection of the humerus, and seems like a single thread of muscular fibre. Professor HUMPHRY speaks of it as arising from the *inner* side of the humerus just beneath the insertion of the coraco-brachialis, an arrangement which I did not see in any of my specimens of Pteropine Bats; in them its origin is anterior, and in *P. edulis*, though inclining slightly to the inner side, yet still on a plane, is inclined to the coraco-brachialis. This muscle is largest proportionally in the *Eleutherura marginata*; it is also large in *Cephalotes*, and arises from the front of the humerus, commencing below the pectoral ridge but not near the coraco-brachialis; its insertion is behind the long head of the biceps. Professor HUMPHRY found in the female *Pteropus* a band of this muscle going into the biceps, which I did not see in any of my specimens. In *Cynonycteris* it was exceedingly feeble.

Triceps longus in *Plecotus* arises as usual from the tricipital subglenoid ridge; it has a single thick upper belly and a long tendon, which is separate from the tendon of the rest of the muscle until near its insertion; it is overlain by a thin dorsi-epitrochlear expansion, more areolar than muscular in structure, but which comes off from the tendon of the latissimus dorsi. In the other Vespertilionine Bats the long head is double, composed of two perfectly distinct muscles, one of which arises a little above the other. In *Vampyrops* there are also two scapular heads, which very soon coalesce. In *Artibeus jamaicensis* there are two similar long heads, but they do not unite so high up.

In *Macroglossus* the origin is single, wide, with no trace of a dorsi epitrochlearis, and coalesces with the humeral heads before its insertion; it is similar in *Cephalotes*, but in *Megaderma* it is distinctly double, the external being large with a tendinous origin, the internal being tendinous and fleshy; they are quite separate to the lowest fifth; no trace of a dorsi epitrochlear exists in this species. MECKEL says that the triceps in the Bat has three heads of the same length; one of these is scapular, two are humeral, arising from the upper part of that bone, while a fourth head arises from the back of the humerus lower down. In *Pteropus* Professor HUMPHRY describes finding some fibres from the acromion deltoid passing into this muscle; but this arrangement I have failed to find in any species, although in *Eleutherura* and *Pteropus* they are closely applied.

Professor HUMPHRY also found some fibres passing into the triceps from the posterior surface of the tendon of the coraco-brachialis (*loc. cit.* p. 305); this likewise I have not found, except in the three species of *Pteropus*. In *Eleutherura* the triceps has two scapular heads, of which the external is three times larger than the internal. The long head is partly double at its origin in *Pteropus edulis*.

As already mentioned, the only traces of the dorsi epitrochlearis exist in the Vespertilionidæ; in all of these it is extremely weak, but it is largest proportionally in the Pipistrelle.

The humeral head of the triceps is single in *Megaderma* and is external; indeed Professor AEBY regards it in all Bats as single and with germs of two lateral heads (SIEBOLD & KÖLLIKER'S Zeitschrift, x. p. 41). In *Rhinolophus diadema* there is a single long external humeral head and a double scapular origin, and no fibres for the lower part of the back of the humerus. In *Cephalotes* there is a large external humeral origin ascending to the head of the humerus, and a small internal slip separated by the musculo-spiral nerve. In *Vampyrops* the two parts are separate, but soon coalesce. In *Plecotus* the humeral triceps is excessively weak and single; it is the same in the Pipistrelle, a little stronger in *Vespertilio murinus* and the Noctule; in all the fibres pass down the humerus, and are inserted into the extremity of the ulna. In all the species a detached sesamoid bone exists in the tendon above the extremity of the ulna, exactly resembling a patella; this has been long known, having been described by GRATIOLET and GEOFFROY ST. HILAIRE ("Sur l'existence d'un osteïde dans le tendon de l'extenseur de l'avant-bras," Nouvelle Bulletin Scient. Philomath. p. 158, 1826).

The musculo-spiral nerve winds round the humerus at its lower fourth, lower in *Megaderma* than in any other species; the ulnar nerve passes along the brachial artery, then passes behind the inner condyle, sending a filament to the little finger, one to the dactylopatagium latus, and two to the back of the forearm; this arrangement was easily traceable in *Noctulina*.

The proportion between the flexors and extensors has been studied by Professor AEBY of Basel; he finds the triceps to be 25·65 per cent., the biceps and brachialis 32·13 (in Table xvi. p. 86 he has misplaced these numbers; but this is as they should be from his data, p. 85).

The muscles of the forearm are singularly beautiful and well deserve a careful study; the flexors are inferior in strength to the extensors in the forearm; but this is exactly made up by the preponderance of short flexors in the manus, which render these groups of muscle nearly equal; the motions which they produce are simple flexion and extension in a single plane: rotation of any kind is not permissible in the elbow- or wrist-joints; as the latter is only a single forearm bone, its possibilities of motions are thereby simplified. The usual four groups of muscles, supinator, pronator, flexor, extensor, are represented in general as follows:—

Pronator radii teres (Plate XIV. figs. 1, *b*, & 5, *d*) is said by CUVIER to be absent, as well as the pronator quadratus and the supinators (Leçons, i. p. 298). MECKEL admits

the presence of this muscle, but denies the existence of a supinator longus; this muscle arises from the inner condyle and is inserted into the upper fourth of the anterior and internal aspect of the radius; its origin is tendinous, the main body and insertion are fleshy; this is its arrangement in *Megaderma*, *Rhinolophus*, *Pteropus*, and *Macroglossus*: it occupies only one fifth in the *Vespertilio murinus*; this accords with MECKEL'S description: it covers one third fully in *Vampyrops*, *Pteropus Edwardsii*, *Cephalotes*, *Plecotus*, *Synotus*, and *Noctulina*, about two fifths in the Pipistrelle. In all it overlies the median nerve which supplies it; in none has it an ulnar or radial origin. The insertion is into an oblique ridge on the radius. This muscle can only act as a feeble flexor of the elbow.

Pronator quadratus is absent in all.

Supinator radii longus (Plate XIV. fig. 5, *c*), whose existence was first demonstrated by HUMPHRY, exists in all except the *Noctulina* and Pipistrelle. It arises above all the other ecto-condylar muscles, and separates from them immediately below the musculo-spiral groove, and is inserted either into the external and anterior surface of the radius immediately opposite those of the last-described muscle, or else into the integument of the front of the forearm. In *Plecotus* the insertion is into the upper fourth of the radius; in *Cephalotes*, in which it arises higher than in any other species, the insertion is into the upper point of trisection of the forearm; the origin is higher in *Macroglossus* than in *Vampyrops*, but lower than in the last. In *Megaderma* is a distinct fine band, which is inserted into the uppermost part of quadrisection of the radius. In *Eleutherura* it has no bony attachment. This muscle can only act as a simple flexor, as AEBY has pointed out (*l. c.* p. 46); it is supplied by a twig from the large musculo-spiral nerve which lies in front of it. The external cutaneous nerve crosses it, having passed over or under (never through, except in *P. edulis*) the coraco-brachialis muscle and behind the biceps; it is then distributed to the propatagium.

Supinator brevis is a thick simple muscle, in all arising from the outer condyle and inserted into the upper fifth of the radius; it is beneath and connected to the other extensor muscles; its fibres run vertically downwards and a little forwards to be inserted above those of the supinator longus, nearly opposite to those of the pronator teres; no nerve pierces this muscle, as there is no posterior interosseal branch from the musculo-spiral nerve in any Bat which I have examined.

From the external condyle I have seen a few fibres arising in *Vampyrops*, and passing into the skin of the plagiopatagium; these are very short, and resemble the humero-cutaneus described before. KOLENATI, in describing the forearm-muscles, says of them, "schicken von ihren Köpfen Muskelfasern zu den Dactylopatagien;" possibly it may be some band like these that he refers to, but these go to the plagiopatagium. No other author alludes to them; I found them also in *Plecotus*, in which they extended for the upper sixth of the forearm.

Flexor carpi radialis (Plate XIV. figs. 1, *c*, & 3, *a*) is the second most anterior muscle from the inner condyle; its origin is conjoint with the pronator, but it soon becomes separate, and ends in a tendon which runs to the polliceal side of the wrist. In *Macroglossus* its insertion is into the scapho-lunar bone, into the trapezium, and into the base

of the second metacarpal; of these three the trapezial slips come off first from the outer edge of the tendon, then the remaining part bifurcates; the tendon for the scapho-lunar bone is the largest. In *Vampyrops* its insertion is purely into the trapezium; in *Plecotus* it is purely into the second metacarpal; in the Pipistrelle it seems lost on the carpus; it is absent in *Noctulina*; attached by a single insertion in *Pteropus Edwardsii* to the ulnar side of base of the metacarpal of the index, according to Professor HUMPHRY; it has a single tendon to the scapho-lunar bone in *Cephalotes*, to the base of the index metacarpal in *Megaderma*. In *Artibeus* it is single and simple.

Flexor carpi ulnaris (Plate XIV. figs. 1, *e*, & 3, *k*) arises principally from the subolecranon part of the ulna, but generally receives a small slip from the inner condyle; these two heads present the usual relation to the ulnar nerve which separate them. CUVIER says this muscle arises from the common fleshy mass at the condyle, a description which will be seen to be erroneous in almost every species. In *Noctulina* this muscle, however, has no olecranon origin; it continues fleshy longer than most of the other flexors, and is inserted in *Noctulina* into the transverse process of the os magnum; the ulnar nerve is internal to its origin, then gets under it and is external for its whole length. In *Macroglossus minimus* its insertion is threefold, into the transverse process of the os magnum, to the base of the fourth and fifth metacarpals, and by a narrow thread which detached itself high up into the origin of the abductor minimi digiti. CUVIER describes it as inserted into the first phalanx of the fifth digit; I did not find this mode of insertion in any specimen. In *Pteropus Edwardsii* HUMPHRY only found a single tendon inserted into the distal margin of the transverse process of the os magnum opposite the interval between the third and fourth metacarpals; in *Pt. edulis* it was much the same, and the muscle was large and fleshy. In *Cephalotes* it has an origin from the supraolecranon sesamoid bone, and is inserted into the fourth and fifth metacarpals and into the abductor minimi digiti. *Plecotus* has this muscle also attached to the fifth metacarpal. In *Vampyrops* and *Megaderma* it arises solely from the olecranon; in *Artibeus* it is also ulnar; in *Cynonycteris* its origin is condylo-ulnar; in *Vampyrops* it has a wide, apparently double tendon of insertion into the os magnum and the fifth metacarpal; in *Megaderma* it has a small round ossicle in its tendon in the palm attached to the os magnum and to the bases of the fourth and fifth metacarpal bones; from this ossicle the fourth and fifth finger interossei arise.

Professor HUMPHRY describes two flexor muscles for the digits; one of these he calls flexor sublimis digitorum, the other flexor profundus. A careful study of these two muscles in the whole series does not bear out the first part of this recognition: the so-called superficial flexor is really a palmaris, as will be seen from the nature of its insertion; the deep flexor is a combined flexor profundus digitorum and flexor pollicis.

In *Vampyrops* the palmaris arises from the internal condyle and from the upper part of the radius; it soon becomes tendinous, and passing superficial to the other parts at the wrist, it is inserted, by two flat slips, into the metacarpal bone of the pollex, one at either side; a third equally flat band is attached to the metacarpal bone of the index, and a

fourth to that of the middle finger; none of these extend beyond the bases of the metacarpals: the muscle as well as the tendon is superficial. In *Macroglossus minimus* its principal origin is radial, and its insertion is by two tendons, one into the base of the pollex metacarpal, and one which stretches to the base of the first phalanx of the index. Professor HUMPHRY found in *Pteropus Edwardsii* that one tendon of this muscle was inserted into the sesamoid bone on the ulnar side of the metacarpo-phalangeal joint of the pollex, and the other had a slight attachment to the metacarpal bone of the index. and was continued on to the base of the second phalanx of that digit. In *Pteropus edulis* it is also simply metacarpal in its insertion, and sends no distinct slip to any of the phalanges. In *Plecotus* this muscle is of extreme tenuity, and is inserted into the metacarpal bones of the pollex and index; in the Pipistrelle it goes to the first phalanx of the middle and fourth fingers. In *Cephalotes* it springs from the inner condyle, and its tendon is flattened over the rest at the wrist to be inserted into the metacarpal bones of the pollex and index. In *Rhinolophus speoris* and *diadema* its insertion is threefold, into the pollex, medius, and index; the slip to the index is very thin, the origin is superficial, and the fleshy portion very short. In *Megaderma* it is slender, and its tendon is tightly tied to the next; its muscle is deep, arising from the radius; its insertion is into the thumb, index, and middle fingers, at their metacarpo-phalangeal articulations: the tendons in all are flat, superficial, and in the last especially they are lost in the fascia and are not attached to bone. In *Artibeus* the arrangement is as in *Vampyrops*; in *Cynonycteris* it is attached as in *Cephalotes* (Plate XIV. figs. 1, *l*, 2, *a*, & 3, *d*).

Taking together the flatness and fascial connexion, the metacarpal insertions and superficiality at the wrist, where this tendon runs in a separate sheath under a thin band of fibrous tissue, but over the main body of the annular ligament, all these together seem to indicate that it is a palmaris, not a flexor sublimis. The existence of a polliceal slip is not what we might expect in a flexor sublimis. In *Noctulina* this muscle is absent altogether.

Flexor digitorum communis (Plate XIV. figs. 1, *d*, 2, *h*, 3, *g*, & 5, *e*) (profundus of HUMPHRY) in *Noctulina* arises from the inner condyle, from the upper third of the radius, and is inserted into the base of the first phalanx of the pollex, into the second phalanx of the medius, and the origin of the interosseous muscle for the polliceal side of the ring-finger. In *Pteropus Edwardsii* and *medius* it arises from the inner condyle, from the radius and ulna; it passes under a strong arch at the wrist to be inserted into the last phalanx of the pollex, into the index and middle fingers at their last phalanges; the tendon to the middle finger in the female *Pteropus Edwardsii* became fleshy for a considerable part of its extent (HUMPHRY). In *Pt. edulis* it was as in the other species, but no part of the tendon became fleshy.

This is the only long flexor muscle of the digits present in most of the Vespertilionine Bats, as Professor AEBY describes (*l. c.* p. 66). In *Vampyrops* it arises from the condyle, upper third of the radius and ulna; its tendon passes under the transverse process of the os magnum, and is inserted into the pollex and medius, extending to the terminal

phalanges of each. In *Macroglossus minimus* it is inserted into the pollex and index, and by a fine thread forming the origin of the polliceal interosseous of the middle finger. In *Plecotus* it is also inserted into the pollex and index. In *Vesperugo* and *Vespertilio* it is similar. In *Cephalotes* its origin is as in *Vampyrops*, and its insertion as in *Macroglossus*. In *Megaderma* its origin is merely condylo-radial, and the insertion by three tendons into pollex, medius, and ring, the last tendon being very feeble; it is the same in *Rh. speoris* and *diadema*, only the ring tendon goes to the radial interosseous of that digit. CUVIER says this muscle has five slips to the five fingers, MECKEL says four; both of which statements are incorrect, as will be seen. In *Artibeus jamaicensis* its origin is from the humerus, radius, and ulna, and its insertion into the pollex and medius. In *Cynonycteris amplexicaudatus* it is very similar to the arrangement in *Cephalotes*.

In the left forearm of my specimen of *Vampyrops vittatus* I found a special flexor annularis, as a small thread of muscle ending in a slender tendon which passed to the last phalanx of the ring-finger; it was only found in this specimen and in the *Cephalotes*, and seemed like a detached slip of the flexor profundus digitorum.

Extensor carpi radialis longior (Plate XIV. fig. 4, *j*) is separate in all except *Plecotus*, *Scotophilus*, and the Pipistrelle; in the others it had a perfectly simple and normal course, and was inserted into the base of the second metacarpal bone; it is the smaller of the two, and of course the more superficial; the radial nerve lies in front of it.

Extensor carpi radialis brevior (Plate XIV. fig. 4, *k*) is equally constant and has its normal insertion. I found no sign in any species of the extension of accessory slips from this tendon to the fourth and fifth metacarpal bones, like those described by Professor HUMPHRY; so I suppose that they also should be considered as muscular anomalies, especially as it was only in one of his specimens (male) that he found them. MECKEL describes this muscle as inserted into the three outermost metacarpal bones, but I found no fibres in any species extending to the polliceal metacarpal.

Extensor carpi ulnaris (Plate XIV. fig. 4, *a*) is a very small muscle when present, and I missed it in the smaller Vespertilionine specimens. In *Megaderma* and *Rhinolophus* it is extremely small; it is in all principally ulnar in its origin, entirely so in *Noctulina*, condylo-ulnar in the others; it is inserted into the fifth metacarpal in most, into the fourth and fifth in *Noctulina*, into the same bones in *Artibeus* and in *Cynonycteris*, extending to the first phalanx in *Cephalotes*; it is purely metacarpal in insertion in *Macroglossus*.

Extensor ossis metacarpi pollicis (Plate XIV. fig. 4, *f*) is constant in all the Cheiroptera, and displays no remarkable feature, arising high upon the back of the forearm from the ulna and radius; its tendon passes, as usual, over the radial extensors of the carpus, and in most of the species is inserted into the base of the metacarpal bone of the pollex simply. A sesamoid bone exists in almost every species at the lower end of the tendon where it lies on the wrist-joint. In *Cephalotes* it rises as high as the elbow-joint, to the external ligament of which some of its fibres are attached. In *Megaderma* it has a large radial attachment. I found no special insertion into the radial extremity of the transverse process of the os magnum in any species; but in some of the large ones, as

*Pteropus edulis*, a fibrous band connected the sesamoid bone to it; still in these, as in the others, the main insertion is into the pollex metacarpal. The sesamoid bone is very large in some of the species, and has a distinct articular facet for the scapho-lunar in *Eleutherura*: I did not find it in *Scotophilus hesperus*; but the parts are so small that I may have easily missed it (CUVIER says of this muscle that it crosses the extensor carpi ulnaris at the wrist; but this is obviously an error).

Extensor secundi internodii pollicis arises from the back of the radius at its lower half; it crosses the radial extensors at the wrist, and is inserted as usual. In *Vampyrops* I missed it in the left arm, but found it in the right. In *Megaderma* it springs from the olecranon, but it is very large in *Rhinolophus diadema*. In all the other specimens it is normal and large.

Extensor indicis is a separate muscle in all but *Megaderma* and *Cephalotes*, in which it is joined to the extensor digitorum; it arises from the radius and is inserted into the last phalanx of the index, but only into the metacarpal bone in *Megaderma*. The existence of this muscle was not recognized by MECKEL or CUVIER, and AEBY says that he failed to find it in the Bat (*loc. cit.* p. 60).

In *Macroglossus minimus* I found this muscle replaced by an extensor of the pollex and index, similar to the muscle which exists in the Dog, Fox, Panther, and Wolf. It arose below the extensor ossis metacarpi pollicis, and was inserted into the first phalanges of the pollex and index. In *Cynonycteris* and *Plecotus* I found a corresponding muscle coexisting with the extensor indicis and the extensor secundi internodii pollicis, but I have not found it in any other species.

Extensor digitorum communis arises from the outer condyle of the humerus as well as from the radius; it passes along the ulnar side of the forearm, and at the wrist projects to the ulnar side; it ends in three tendons, which pass to the three ulnar fingers. In *Megaderma* the tendon for the second finger is very weak; in *Cephalotes* the extensor indicis is slightly joined to it; the union is more close in *Megaderma*. CUVIER describes this muscle as inserted into the last phalanges of all the fingers, but in none does this muscle proper send a tendon to the index. As all the tendons cross on the ulnar side of the wrist, that for the middle finger crosses the back of the fifth, fourth, and third metacarpals, that for the fourth crosses the fifth and fourth, and so on.

The muscles of the manus are as follows. For the pollex I have found:—

1st. An abductor pollicis (Plate XIV. fig. 5, *g*), from the scapho-lunar to the base of the first phalanx of the pollex; on its outer side this is present in *Macroglossus*, *Pteropus*, *Noctulina*, *Megaderma*, and the other large Bats.

2nd. Opponens pollicis, arising from the trapezium and scapho-lunar bones, inserted into the metacarpal bone of the pollex; this I have only found in *Noctulina* and *Macroglossus*.

3rd. Flexor pollicis brevis radialis, from the scapho-lunar bone and from the radial side of the os magnum to the base of the radial side of the first phalanx of pollex; it is

present in all the species, and is large in *Noctulina*, *Cephalotes*, *Megaderma*, and *Eleutherura*: this muscle is always separate from the foregoing.

4th. Flexor pollicis brevis ulnaris, from the os magnum to the ulnar side of the first phalanx, is also always present.

5th. An adductor pollicis is present in *Macroglossus* and *Megaderma* as a small transverse bundle from the second metacarpal to the base of the first phalanx of the pollex.

For the little finger there are in nearly all Bats the following muscles:—1st. Abductor from the unciform; in *Megaderma* it arises from the palmar ossicle, and in *Macroglossus* and *Cephalotes* from a thread of the tendon of the flexor carpi ulnaris; it is inserted into the first phalanx of the little finger. 2nd. Opponens minimi digiti is very small and rudimental in *Macroglossus*, absent in most of the others, and existed in that species as a thin filament from the carpus to the metacarpal bone. 3rd. Flexor brevis minimi digiti is the radial interosseous muscle for this digit: its origin is peculiar; it springs from the extremity of the transverse process of the os magnum, it lies superficial to the origins of the other interossei muscles and to the tendon of the flexor profundus digitorum et pollicis under cover of the palmaris longus, and it is inserted into each side of the second phalanx by a split tendon.

For the index-finger there is an opponens, or a metacarpal flexor, in *Noctulina*; there are in the others two interossei present.

For the middle finger there are also two interossei; one of these in *Macroglossus*, as already described, arises from the flexor digitorum tendon, the other arises from the os magnum and trapezoidale. In *Noctulina* these two muscles are combined, but the tendon is double; in the same species this muscle arises in common with the interosseous for the ring-finger, which is also single, as it is in all the species, but has a double tendon. There are no anconei muscles in the forearm, nor is there any palmaris brevis in the hand. The thumb-muscles are supplemented in their action by the occipito-pollicalis above described.

*Muscles of the Abdomen.*

Both in males and females the abdominal wall-muscles are very thin, and invested by a strong elastic layer of fascia, which lays immediately under the skin; from this arises the pectoralis quartus, and under it is the external oblique, which arises from the five or six lower ribs, indigitating with the serratus magnus; it soon becomes tendinous, and is inserted over the rectus into the linea alba; its lower border forms a strong Poupart's ligament.

The internal oblique and transversalis combined form one inseparable muscle (except in *Pteropus*, in which they are for the upper half of the abdomen perfectly separable), which underlies the last, and passes behind the rectus. Its origin is from the lumbar fascia and ilium, and apparently from the lower margin of the lowest rib; its insertion is into the linea alba; none of its fibres go in front of the rectus. For the lower quarter of the abdomen these muscles are very thin and fascial in nature. Piercing its

lowest border is the spermatic cord, which appears to pass under, not over, Poupart's ligament; but of this I am not sure.

Rectus abdominis is the largest of the abdominal muscles, and is placed between the two before mentioned; it arises from the pubis by a narrow fleshy head, rapidly widens and ascends to be inserted into the first rib in *Pteropus*, *Macroglossus*, *Plecotus*, *Cephalotes*, *Eleutherura*, *Cynonycteris*; into the fourth, fifth, and sixth ribs in *Vampyrops vittatus*; into the third, fourth, fifth, sixth, and seventh rib-cartilages in *Artibeus*. In the females a space intervened between the two recti above the pubis. HUMPHRY (*loc. cit.* p. 302) and MECKEL say that no tendinous intersections exist in this muscle; but in *Pteropus* there is a complete intersection under the origin of the pectoralis quartus about half an inch below the ensiform cartilage. In *Cephalotes* there is one well-marked linea transversa immediately below the ensiform cartilage. In *Eleutherura* there is one partial line in this position, and a complete one a quarter of an inch above.

MECKEL describes this muscle as being inserted into the ensiform cartilage, into the cartilages of the fifth and sixth ribs, and says that they send a wide straight slip to the humerus; here he has evidently fallen into the mistake of regarding the pectoralis quartus as being connected with this muscle; in no species is it connected to the ensiform cartilage.

Pyramidalis is very thin and small, only present in the large Pteropine Bats. MECKEL states that it is absent, and, indeed, it is indetectable in the smaller species. Professor HUMPHRY and I have found it very strong in *Pteropus Edwardsii* and *edulis*, its lower fibres being nearly transverse in the female.

The diaphragm has a wide costo-xiphoid deficiency in *Cephalotes*, and is closely attached to the liver by a wide coronary ligament. The crura are very large, especially in *Megaderma*; the muscular fibres are long, the tendon in the centre small. CUVIER notices the great size of the crura, which are placed like a vertical fleshy septum in the abdomen. In *Pteropus edulis* this is especially the case.

Quadratus lumborum is not absent as CUVIER supposes, but is long and thin, consisting of two sets of fibres, ilio-costal and ilio-lumbar; the latter, as usual, internal and larger; there are no lumbo-costal fibres; the second set pass to the three upper lumbar vertebræ in *Megaderma*. In none of the other species does this muscle present any features of interest.

Psoas parvus is present in all, and generally large, as CUVIER remarks (Leçons, i. p. 349). MECKEL also notices its presence, and gives as its origin the first lumbar vertebra. In *Noctulina* it has a short muscular part and a long tendon. In *Cephalotes* it is much larger. In *Megaderma* it is very thick, short, and fleshy for its whole extent. Its insertion in all is into the prominent spine of the pubis. In all its origin is limited to one or two vertebræ; HUMPHRY gives two or three dorsal and the same number of lumbars, and says some fibres are continuous into the pectineus. I was, however, able with care to separate it from this muscle in all my specimens.

*Muscles of the Lower Limbs.*

The position of the parts in these limbs is so remarkable that a brief review of the arrangement is necessary before describing the muscles. The variation in position from the usual disposition of hind limbs in Mammalia may be described as twofold. 1st, the limbs instead of having suffered a rotation forwards from their embryonic position, have been rotated backwards, and this has caused the following peculiarities: the knee-joints are directed backwards and outwards, the tibial side of the leg inclines outwards and forwards, the fibular side inwards, the plantar surface of the foot is directed forwards, the outside of the femur is directed backwards and a little inwards, the adductor aspect of that bone looks forwards and outwards; of its two tuberosities the lesser or tibial is external and anterior, the greater or fibular is internal and posterior; the head of the fibula is defective. This remarkable disposition of parts, it will be seen, is precisely similar to the usual arrangement in the fore limb, and the guides to homologies derived from it are of extreme value. With the knee in the position of the elbow, the ulna and fibula, radius and tibia are thrown into precisely similar positions; so are the great toe and the pollex, the external condyle (humerus) and the inner condyle (femur), and *vice versâ*, the great trochanter and the lesser humeral tuberosity, the lesser trochanter and the greater tuberosity. Thus the system of homologies which Goodsir proposed, and which after him has been supported by Huxley, Mivart, Flower, and Humphry, receives an immense support from this arrangement.

The second peculiarity in the hind limbs of the Cheiroptera is the position of the pelvis. The ala of the ilium is everted, so that the iliac fossa is anterior and external, the ilia rod-like, the pubes and ischia project forwards, and the lower outlet looks forwards.

From these peculiarities in position it can easily be understood that the hind-limb muscles in some respects depart from the usual mammalian positions in some respects, as will be seen hereafter.

Psoas magnus is a large muscle arising from the three uppermost lumbar vertebræ except the first in *Cephalotes*, from the lumbar vertebræ, sacrum, and side of the ilium in *Megaderma*, from the vertebræ and margin of the ilium in *Cynonycteris*. In *Artibeus* the muscle arises as in *Megaderma*, in *Pteropus edulis* it is attached to the lower lumbar vertebra only. Professor Humphry describes it in his specimen of *Pt. Edwardsii* as arising from the lumbar vertebræ external to the psoas parvus, from the front of the sacrum and from the ilium, passing under the pubic spine to the anterior trochanter of the femur. Meckel says its origin is from all the lumbar vertebræ; and Cuvier, strangely enough, states that this muscle does not exist (Leçons, i. p. 359).

Gluteus maximus (Plate XIV. fig. 14, *h*) is triangular and flat; it arises from the posterior border of the crest of the ilium and sacral spines in *Pteropus Edwardsii* and in *Megaderma*, from the sacrum alone in *P. edulis*, from the sacrum and first caudal vertebra in *Noctulina*, from the sacrum in *Cephalotes*, from the ilium and sacrum in *Artibeus*, from the sacrum and upper two caudal vertebræ in *Cynonycteris*; it is inserted into the upper half of the thigh in *Noctulina*, the upper third in *Megaderma* and *Rhinolophus* as well as

in *Cynonycteris*, to less than the upper third in *Pteropus*, more than half in *Macroglossus* and *Eleutherura*.

Gluteus medius (Plate XIV. fig. 10, *a*) is the usual thick external pelvic muscle, and occupies in all the outer side of the ilium. In *Plecotus* it is short and thick, in the Pipistrelle it is long and narrow, much thinner in *Pteropus*, triangular in *Artibeus*, and very thick in *Cynonycteris*; its insertion in all is into the posterior trochanter. MECKEL describes it as a small muscle; but it is larger than the gluteus maximus; the gluteus minimus is absent in all, as MECKEL remarks; CUVIER mistook the iliacus for it.

Gluteus quartus (Plate XIV. fig. 10, *c*) exists as a separate marginal muscle in the Pipistrelle, in the Vampyre, *Megaderma*, and *Rhinolophus*. None is present in *Noctulina*, *Plecotus*, *Cephalotes*; where it exists it passes from the margin of the ilium in front of the gluteus medius, and is inserted in front of the external trochanter.

Pyriformis (Plate XIV. fig. 13, *c*) is not a distinct muscle in *Vampyrops*, *Cephalotes*, and *Noctulina*, but in *Megaderma* and *Eleutherura* it exists as a separate muscular band above the sciatic nerve; it is the same in *Rhinolophus*, and partly separate at its origin in the Kiodote. CUVIER says it is absent (Leçons, i. p. 359); MECKEL confounds the next muscle with this. In *Artibeus* it is united to the gluteus.

Caudo-femoralis (Plate XIV. fig. 10, *e*, *f*) (gubernator caudæ, HAUGHTON) is a muscle which passes from the first caudal vertebra to the external part of the upper point of trisection of the femur; it is thick and strong in *Plecotus*, absent in the Pipistrelle, double in *Vampyrops*, crossing the insertion of the gluteus medius. In the Noctule it arises under the extensores caudæ from the first and second caudal vertebræ, and is inserted into the upper two fifths of the outside of the lower border of the femur, lying over the tendon of the gluteus maximus. In *Cephalotes* it is small, thick at its origin, and inserted into the middle of the femur. In *Megaderma* it is very large, and springs from the sacrum and two caudal vertebræ. It is double and largest of all in *Rhinolophus diadema*; it is also double but smaller in *Macroglossus*. MECKEL takes this to be the pyriformis; but it is quite separate, and has the same relation to the pyriformis that the latissimus dorsi bears to the teres major.

Quadratus femoris (Plate XIV. fig. 12, *h*) is perfectly distinct in all the species, arising below the obturator muscle and passing from the tuber ischii to the root of the great trochanter. It is small in *Noctulina*, larger in *Cephalotes* and *Macroglossus*. CUVIER says it does not exist.

Iliacus internus (Plate XIV. figs. 7–9, *d*, 10, *b*, 11, *a*) is a very remarkable muscle, having a purely external origin, springing from the outside of the ilium close to the crest, external to the psoas, and separated from the gluteus medius by the extensor cruris; it is inserted into the anterior trochanter; it is parallel to the psoas in general, very small in *Megaderma*. CUVIER says it is absent (Leçons, i. p. 357). It is exceedingly constant, and exhibits no other features of interest in any species.

Gracilis (Plate XIV. fig. 7, *e*) is the largest of the internal or anterior femoral muscles, and has usually a wide origin; in *Megaderma* it overlies the adductors and arises from the

whole of the margin of the pubis and ischium; it very soon becomes tendinous, and is inserted into the anterior aspect of the tibia two lines below the head. In *Plecotus* and *Vesperugo* it is the same. In *Noctulina* it is larger and with longer fibres, and inserted one eighth below the head of the tibia. In *Cephalotes* it is smaller, springing from the ilio-pectineal line, and inserted as usual; in this animal (Plate XIV. fig. 11, *h*) there is a separate slip of this muscle which springs from the pectineal point to be inserted along with the rest of the muscle; at its origin it lies between the gracilis and the pectineus, and is superficial to the last: possibly this slip might represent the sartorius; if we take into account that in some Artiodactyls and Edentates this muscle undoubtedly does arise from the pectineal eminence, it gives some colour to the supposition. If this be not the sartorius there is then no trace of that muscle in the entire series; this is the case also regarding the tensor vaginæ femoris, of which no Bat shows the slightest trace. The tendon of the gracilis in no species joins inseparably that of the hamstring, but, as HUMPHRY found in his individuals of *Pteropus Edwardsii*, there is in the three species of this genus a slight adhesion. CUVIER groups this muscle and the hamstrings together as a bicipital single muscle.

Pectineus (Plate XIV. fig. 8, *i*) lies under the gracilis, or posterior to it; it arises from the horizontal ramus of the pubis, and is rounded at first (HUMPHRY); its insertion is immediately below the tendons of the psoas and iliacus. In *Noctulina* it is higher up than in most of the others, not covered, only overlapped by the gracilis; it is very small in *Megaderma*, larger in *Macroglossus*. In *Pteropus edulis* it is excessively small, indeed least of all; in *Artibeus* it is largest, in *Cynonycteris* intermediate in size.

In the Pipistrelle there is but one adductor, as in *Plecotus*, *Vampyrops*, *Synotus*; this arises from the pubis and ischium between the last and the obturator externus; its insertion is into the anterior part of the thigh, below the pectineus for a varying extent. This muscle is bilaminar in *Pteropus Edwardsii*, very faintly so in *edulis*; the upper part or adductor brevis is small, the lower or magnus extends three fourths down the bone. In *Noctulina* it is much the same, the fibres extending for the upper half of the femur. In *Cephalotes* and *Macroglossus* (Plate XIV. fig. 8, *j*, *k*) the muscle is bilaminar also, and extends to the same distance; and this is the case in *Megaderma* and *Eleutherura*. MECKEL and CUVIER only recognize a single adductor, which they say only extends to one third (CUVIER) or one half (MECKEL) of the thigh. HUMPHRY conjectures that the pectineus may contain in it the germ of the adductor longus. An upper part of this muscle HUMPHRY supposes might be a quadratus femoris, and an external part separated by the sciatic nerve he supposes might be a biceps; but there scarcely exists any anatomical ground for this division.

The biceps muscle is absent in all the Bats, as noticed by all anatomists.

Obturator externus (Plate XIV. fig. 9, *m*) arises from the outside of the obturator foramen, winds round as usual, and is inserted into the trochanteric fossa; it is square in *Vampyrops*, triangular in *Noctulina* and *Cephalotes*, very small and in two bands in *Megaderma*.

There is no obturator internus, except in *Megaderma*, in which a few fibres of the gemellus extend to the inner side of the obturator membrane.

Gemellus exists, in *Pteropus*, *Megaderma*, and *Vampyrops*, as a band of fibres from the tuber ischii to the trochanter above the obturator externus; it is absent in the other genera.

Rectus femoris (Plate XIV. fig. 13, *d*) has a single iliac head in *Eleutherura*, has two, as usual, in *Noctulina*, *Vampyrops*, *Cephalotes*, *Macroglossus*, *Megaderma*, in the last of which it is largest of all proportionally; it joins the rest of the extensor at the middle third of the thigh, and is inserted with it.

Extensor cruris femoralis (cruræus, Plate XIV. fig. 13, *e*) is but a single band in all the Bats, which arises from the upper fourth of the femur, and joins the last to be inserted into the tubercle of the tibia; the tendon crosses the knee, but has no patella in it. This muscle is largest in *Megaderma*, in which there is an obscure sign of a division.

Semitendinosus (Plate XIV. fig. 14, *f*) is the most posterior and internal of the two hamstrings; it arises from the back of the tuber ischii, and is inserted separately below and behind the semimembranosus. In *Cephalotes* it is small, and has a caudal origin; it has a long tendinous origin and a longer tendinous insertion in *Megaderma*. In *Pteropus* it has a caudal origin and is penniform; but in none does it present the curious inscription found in the higher Primates.

Semimembranosus (Plate XIV. fig. 14, *g*) in *Noctulina* is once and a third larger than the last-named; its insertion is above and in front of the last; its origin is also ischiatic, and it is larger than the last in *Cephalotes* and *Eleutherura*. In *Rhinolophus* these two muscles, though double at origin, have only a single insertion; and in *Megaderma* the semimembranosus is either absent or fused with the gracilis. In *Pteropus* its insertion is slightly joined to that of the gracilis, and its origin is purely ischiatic.

The leg-muscles are in the smaller Bats exceedingly small and difficult to be separated; the flexor aspect is directed forwards, and there is no trace of popliteus, soleus, or plantaris in any, with one exception, viz. on the back of the knee in *Vampyrops* I found a few oblique fibres like a rudimental popliteus (Plate XIV. fig. 17, *b*). MECKEL says there is a soleus, but this is an obvious mistake. The gastrocnemius is a very delicate muscle with two heads, except in *Megaderma* (which has only an inner head); these are from either condyle, and the external head, or that from the tibial condyle, has a sesamoid bone (Plate XIV. fig. 16, *c*) in most species except *Noctulina*. This muscle lies at the inner part of the leg, has a long tendon, and ends in the os calcis.

The digital flexors are two in number as usual. The flexor digitorum longus arises from the upper part of the back of the tibia; it passes down the outside of the leg, and is crossed by the tendon of the tibialis posticus; having passed the os calcis, it is joined by the next muscle: it is small in *Cephalotes*, still smaller in *Megaderma*, largest in *Eleutherura*.

Flexor hallucis longus arises from the fibula for its whole length, and from the slender

fibrous thread above the summit of that bone (which is not complete up to the knee); it meets the last muscle at the ankle, and the two tendons fuse. In *Noctulina* they are equally distributed to the five toes. In *Macroglossus* this muscle supplies the entire of the great toe, sends a fine thread to the fifth, forms fully half the tendon to the second and fourth, and sends an exceedingly thin filament to the third; this toe, half the second and fourth, and the fifth are supplied by the tibial flexor; this extends up to the femur in *Megaderma*, and in this the tendons are blended indistinguishably, except that the inner toe is only supplied by this muscle. In this animal likewise a thread of muscle passes from the os calcis to the tendon, forming the only rudiment of an accessorius with which I have met in the order (HUMPHRY found none in the *Pteropus*).

Tibialis posticus is very small, and springs from the middle of the back of the tibia, passing to the sesamoid bone behind the ento-cuneiform in *Noctulina*, or to the scaphoid in *Macroglossus*, or to the inner cuneiform in *Megaderma*; it occasionally gets a little accession of fibres from the fibula, as HUMPHRY found in *Pteropus*. MECKEL says this muscle does not exist.

Peronæus longus arises from the fibular condyle of the femur in *Noctulina*, descends to the inner side of the ankle receiving fibres from the fibula, and is inserted into the plantar surface of some of the tibial metatarsal bones (how many I could not say). In *Cephalotes* it does not rise to the femur, but has the same insertion. In *Pteropus Edwardsii* it is inserted into the second metatarsal bone; in *Pt. edulis* it is inserted into the first and second; in *Macroglossus* it is attached to the second metatarsal.

Peronæus brevis is the only peroneal muscle present in *Megaderma*, and passes from the lower half of the fibula to the fifth metatarsal at the external side of the ankle. In *Macroglossus* it passes from the external condyle of the femur to the projecting spur on the cuboid bone; in *Eleutherura* it passes to the fifth metatarsal, sending a peronæus quinti slip to the base of the first phalanx. MECKEL found one peronæus only, and this is the case in the majority of species. Professor HUMPHRY describes a peronæus tertius coexisting with the longus in *Pteropus*, arising from the front of the fibula, and inserted into the metatarsal bone of the fifth toe, with a slip to the extensor tendon of this toe; in his male specimen this is the peronæus brevis, similar to the only peroneal muscle in *Eleutherura*; its *brevis* nature is much more plainly seen in the other species of *Pteropus*, where its tendon is clearly postmalleolar.

Extensor digitorum longus arises in all from the front of the femur by a slender tendon, and from the outer surface of the tibia above the tibialis anticus; its tendon passes in a special groove in the annular ligament, and divides on the dorsum of the foot into four slips, which pass to the dorsum of the four outer toes; this is the arrangement in *Noctulina*, *Macroglossus*, and *Cephalotes*. There are five tendons in *Megaderma*, *Eleutherura*, and *Rhinolophus*.

Tibialis anticus arises from the outside (posterior aspect) of the tibia for its lower half (*Pteropus* and *Megaderma*), two thirds (*Macroglossus*), middle third (*Eleutherura*), or lowest third (*Noctulina*); it is inserted into the metatarsal bone of the hallux in most

species, but only extends into the scaphoid and internal cuneiform in *Megaderma* and *Macroglossus*.

Extensor hallucis longus exists as a separate muscle only in *Macroglossus*; it is very slender, and passed from the interosseous border of the tibia to the hallux. I found no trace of it in any other species.

The dorsum of the foot presented two muscles:—

Extensor digitorum brevis, which in all was moderately strong and passed from the outer side of the tarsus to the four fibular toes. Separate from this in all was the extensor hallucis brevis, which arises from the lower end of the tibia and front of the tarsus, and is inserted into the great toe; this is largest in *Noctulina* and *Eleutherura*.

In the sole of the foot are the following muscles:—

Levator ossis styliformis, a slender muscle from the back of the lower part of the ankle to the upper surface of the styliform bone. This muscle is small, and proportionally largest in *Noctulina*.

Depressor ossis styliformis (styliform muscle of HUMPHRY) starts from the plantar surface of the calcaneum (*Noctulina*), or from the fifth metatarsal bone (*Pteropus* and its allies), to the lower border of the spur.

Abductor minimi digiti, abductor ossis metatarsi minimi digiti, and abductor hallucis were present in all, and displayed no features of particular interest. The flexor brevis digitorum in all divided into four slender bellies, whose tendons supplied the four digits on the fibular side; it was small in *Pteropus*, larger in *Macroglossus*. There were eight lumbricales: one of these arose from the flexor hallucis tendon, and supplied the inner side of the great toe; one arose from the flexor digitorum longus tendon, and supplied the fifth toe on its tibial side; and for each of the other toes there were two, one from the flexor hallucis tendon, and one from the flexor digitorum longus.

The transversalis pedis was very large and double in *Macroglossus*, single and large in the others; in *Pteropus* it was very wide, and stretched from the fifth metatarsal bone and from the first phalanx of this digit, from the fourth and partly from the third metacarpal bones, into the metacarpal bone and first phalanx of the hallux. Professor HUMPHRY, in his description of this muscle, regards its halluceal attachment as its origin, and its minimal attachment as insertion.

There are ten single-headed interossei, one on each side of each digit.

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For purposes of comparison I have dissected two other types of so-called flying Mammals: one the *Pteromys volans*, or Flying Squirrel, of the order Rodentia; the other *Galeopithecus volitans*, or Flying Lemur, of the order Insectivora. As an appendix to the Myology of the Cheiroptera I shall briefly state the muscular peculiarities met with in these species.

In *Pteromys* the cutaneous muscles were:—1st. Carpo-tarsal (Plate XVI. fig. 1, *f*), a strong cord of muscular fibres extending in the margin of the plagiopatagium from the tip of the styliform bone of the carpus to the inner side of the tarsus, and more parti-

cularly to the lower end of the tibia. 2nd. Carpopatagial (Plate XVI. fig. 1, *g*) consisted of radiating fibres starting from the carpal spur, and passing backwards and inwards to be lost in the wing-membrane. 3rd. Coraco-patagial (Plate XVI. fig. 1, *h*), a strong band starting from the tip of the coracoid process, and lost in the plagiopatagium by spreading along with the last. 4th. Coraconotal, deeper and further back than the last, arising, like the dorsi patagial of the Bats, from the integument over all the dorsal spines, and inserted into the coracoid process under the last; this muscle also arises from the fascia over the lower half of the lateral aspect of the thorax, and in it ramify the lateral cutaneous thoracic nerves. 5th. Transversus nuchæ (Plate XVI. fig. 1, *a*), a singular muscle, which I think is the same as the muscle described under this name by Professor F. E. SCHULTZE, of Rostock, joined to the zygomaticus major; it arises immediately below the occipital line from the median line of the back of the neck over the deep cervical muscles, passes forwards and crosses the next muscle to be inserted into the middle of the margin of the lower lip; it runs transversely, lying on the splenius, the next muscle, the masseter, and the ramus of the mandible.

The sixth of the cutaneous muscles is the most remarkable; it may be named jugo-pollicalis (Plate XVI. fig. 1, *b*, *c*): it arises from the zygomatic arch by a flat wide expansion; crossing under the transversus nuchæ, it is inserted into the base of the rudimental pollex; it is only fleshy for about half its course, and it runs in the propatagium.

It is easy to see of these muscles that the last is of the same nature as the continued portion of the occipito-pollicalis, together with the platysma myoides superior; as there is a rudimental occipital trapezius, there is no occipito-pollicalis proper; the others, with the exception of the first and fifth, have their representatives among the Bats, and the nuchal slip of some of the Cheiroptera may be a depressed transversus nuchæ. I could not trace any filaments of the spinal accessory into any part of this group of muscles.

Pectoralis major is divisible into two parts; one of these arises from the upper half of the sternum and the inner half of the clavicle, the other from the lower half of the sternum: it is inserted as usual, and is a small muscle in comparison with its namesake in the Bat.

Pectoralis minor arises from the third, fourth, and fifth rib-cartilages, crosses over the coracoid process to be inserted into the upper part of the greater tuberosity of the humerus. A distinct fourth pectoral arises from the fascia over the ensiform cartilage and upper fifth of the abdominal linea alba, crosses the tendon of the pectoralis minor to be inserted into the humerus even higher up than that muscle.

The clavicular and acromial deltoids are united, and make one small muscle with short fibres, which only occupies a very small section of the outer extremity of the clavicle, and is inserted high up on the humerus; the scapular deltoid lies over the infraspinatus exactly as in the Bats, and its insertion has the same relation to the foregoing muscle as in the Cheiroptera.

Sterno-cleido-mastoideus is not separable into its components, except at its origin; and its insertion is into the paroccipital and into the whole length of the supraoccipital transverse ridge.

The omo-hyoid is large and monogastric, the sterno-hyoids and thyroids simple and large; the digastric has two separate bellies and a central rounded tendon, which is continued from side to side above the hyoid bone as an arch, from which the parallel anterior bellies arise.

The levator claviculæ arises from the middle cervical transverse processes, and passes to the outer extremity of the clavicle and the acromion process. The latissimus dorsi springs from the nine lowest dorsal vertebræ, from the lumbar fascia, and from the three lowest ribs; it is inserted as usual, but its costal portion sends a thick band up to the coracoid process under the coraco-cutaneous and notocoracoid muscles; it is closely tied to the teres major, and the enormous dorsi epitrochlear muscle arises nearly equally from both.

Trapezius is indivisible, and arises from the ligamentum nuchæ, from the inner fifth of the occipital ridge, and from the six upper dorsal spines; its upper part is wide and its lower narrow, and its insertion is as usual. The rhomboid is in two parts; the occipital portion descends nearly vertically and is inserted into the vertebral edge of the præscapula and mesoscapula. On the left side this muscle was in two bands, one arising from the middle line of the occipital bone and inserted into the mesoscapula, the other from the outer third of the supraoccipital ridge and attached to the præscapula; these were continuous on the right. The levator anguli scapulæ arises from the transverse processes of the fifth and sixth cervical vertebræ, and is separated from the last by a fatty mass.

Serratus magnus is divided into two parts, an upper, which is attached to two ribs, and a lower, which extends from the third to the eleventh ribs; this latter part is inserted into the inferior angle of the scapula only; the upper is perfectly separate from the levator anguli scapulæ.

The subclavius is perfectly separate from the sterno-scapular, which overlies the supraspinatus, and is attached to the mesoscapula, the subclavius proper going to the clavicle. The scalenus anticus is large and is inserted into the first rib; the medius and posticus are inseparable, and are attached to the four uppermost ribs. The rectus abdominis ascends to the first rib; the serratus posticus superior is inserted into the upper five ribs below the first, and the inferior into the five lowest. I could find no trachelo-mastoid; but otherwise the deeper neck-muscles were normal, the complexus having no tendinous intersection.

The subscapularis was not nearly so large as in the Bats, and had three tendinous septa in it; there was no subscapulo-humeral separate; the supraspinatus is three times the size of the infraspinatus.

Dorsi epitrochlearis is a large fleshy muscle arising from the tendons of the latissimus dorsi and teres major (rather more from the latter than from the former). It overlies the triceps, is fleshy and thick for its whole length, and is inserted into the inner side of the olecranon process.

Biceps has a small coracoid head joined to the whole length of the coraco-brachialis

longus; the long head crosses the shoulder-joint, with which its bursal sheath freely communicates; the two parts of this muscle join inseparably. The brachialis anticus is large, and extends as high as the neck of the humerus on its outer side. There are two coraco-brachiales: a coraco-brachialis longus (WOOD), extending for the lower half of the bone, even to the inner condyle, and a brevis, thick and fleshy, closely applied to and crossing over the subscapularis tendon.

The pronator teres extends for the upper half of the radius; the flexor carpi radialis has no second head, and a single tendon inserted as usual; there is no palmaris longus. The flexor digitorum is in three parts, two of which are condyloid and one ulnar. The flexor pollicis has a radial origin, but it unites with the three parts of the flexor digitorum, and I could only detect one set of tendons. There is a very small rudiment of a pronator quadratus, consisting of a few fibres overlying the part where the forearm-bones are united together below; these are traceable in the lower third of the forearm. The supinator longus extends from above the outer condyle to the lower end of the radius. The extensor carpi radialis has a single belly with two tendons; there is no extensor minimi digiti, an extensor ossis metacarpi pollicis, and an extensor indicis; the other forearm-muscles display no features of interest.

In the hinder limb of the Flying Squirrel the muscular arrangements are as follows. The gracilis is thin and narrow, the adductor mass is divisible into the following parts:—pectineus (small and round), adductor longus (with a narrow tendinous origin), adductor magnus condyloideus (closely connected to the semimembranosus), adductor magnus superior, and adductor brevis, all quite distinctly separable. The hamstrings are:—semimembranosus, large and fleshy, attached to the upper sixth of the inner edge of the tibia; semitendinosus, with two heads, one arising under the last from the tuber ischii, the other, as in the Beaver, from the spine of the first caudal vertebra, at first lying superficial to the biceps; both uniting, are inserted below the semimembranosus by a tendinous expansion for nearly the second fourth of the inner side of the tibia; biceps is triangular, arising narrow from the tuber ischii, and inserted into the outer and upper third of the leg.

Agitator caudæ passes from the two foremost caudal spines, and is inserted into the lower half of the outer side of the femur on its flexor aspect, as far as the outer condyle.

Gluteus maximus arises from the sacral spines, and from that of the first caudal vertebra; it is inserted into the third trochanter. Tensor vaginæ femoris is moderately thick, and extends to the upper half of the outside of the femur, being inserted into the fascia as usual; its origin is from the iliac crest. The gluteus medius is thick and separate from the largely developed pyriformis. Gluteus quartus is distinct, marginal, and anteriorly inserted. Iliacus is small, separate from the large psoas magnus; and the psoas parvus is thin and flat. The quadriceps extensor cruris consists of a large rectus with a single iliac origin, an equally large vastus externus, and vastus internus and crureus, partially separable. The tibialis anticus is twice the size of the extensor digitorum, and is single; neither muscle rises to the femur.

Of the three peronæi, the brevis is the largest, then the quinti, then the longus. The outer head of gastrocnemius has a sesamoid bone in its origin, from which arises the plantaris, and to this head further down a slender soleus is attached. The tibialis posticus extends up to the small popliteus. The flexor digitorum is single, with five tendons and four lumbricales. There are two interossei for each digit, pollex and minimus included, an abductor of each of the two lateral digits, but no flexor accessorius nor transversalis pedis; a superficial flexor digitorum with four tendons separates the deep tendons from the plantar fascia.

The specimen of *Galeopithecus* which I dissected was very young, and had been found in the act of sucking its mother when she was shot. I obtained it through the kindness of my friend and former pupil, Dr. MacCarthy, R.N. On account of its youth the dissection was not satisfactory in many points, so I have only recorded such things as were unmistakable.

The trapezius arose from the lower third of the cervical region, from the upper two thirds of the dorsal, and extended in an undivided sheet to the scapular spine; the levator claviculæ was a prominent muscle uncovered by the last, and stretching from the transverse process of the atlas to the outer end of the clavicle. The rhomboid was single, and arose from six dorsal spines; it was inserted into the vertebral edge of the post-scapula.

The dorsi epitrochlearis was a very remarkable muscle, and truly verified its name; it arose from the four lowest dorsal spines and extended, fleshy for its whole length, to the inner side of the elbow-joint; it overlay the latissimus dorsi, from which it was perfectly separate. The acromion deltoid was related to the scapular, exactly as in the Bat and the Flying Squirrel, and the latter covered the infraspinatus and teres minor. The triceps longus was single, and its fleshy fibres were short. The cutaneous polliceal muscle in the propatagium arose from the mandibular ramus as far as the chin, being thus plainly identifiable with the platysma superior. The teres minor was moderately large; the supinator longus inserted into the upper half of the radius from the lower fourth of the outside of the humerus. The biceps and brachialis anticus were as usual, the coraco brachialis consisting of a medius and a brevis (Wood). The extensor carpi radialis longior and brevior united in their fleshy portions and with two tendons; the extensor ossis metacarpi pollicis separate and strong.

The sartorius arose from the middle of Poupart's ligament, the gracilis from below the spine of the pubis; they both united at their insertions, and appeared very like the muscles in *Cephalotes Pallasii* described above. The three adductors were separable, as was also the pectineus, a very short muscle. The iliacus was marginal in origin and separate from the psoas. A thick carpo-tarsal band extended, as in the Flying Squirrel, in the margin of the plagiopatagium.

The tibialis anticus had a femoral origin, which was very slender, as well as its usual head from the lower two thirds of the tibia; from the same femoral tendon arose the extensor digitorum, and, indeed, the tendon seemed to belong to this muscle more properly

than to the last. There were two peronæi, longus and brevis, a two-headed gastrocnemius, a flexor hallucis double the size of the flexor digitorum, and a very small tibialis posticus. The tendons of the flexor hallucis and digitorum appeared to blend inseparably.

As I wish to make this paper a simple record of anatomical facts, I forbear to make any comments on the dissections given above; but they will doubtlessly suggest many interesting lines of thought. The comparison between Bird and Bat myology, between the muscles of the Bats and those of other flying mammals, and the relations of the anatomical structure of the Bat's fore limb with its method of flight, are all fertile subjects for study, while the importance of the bearing of the displaced hind-limb muscles in the Bat on serial homology cannot be overrated.

## Explanation of the Plates.

### PLATE XIII.

Fig. 1. Cutaneous muscles of *Eleutherura marginata*, dorsal aspect.

*a*. occipito-pollicalis.
*b*. dorsi patagialis.
*c*. pubo-cutaneus.
*d*. femoro-cutaneus.
*e*. ischio-cutaneus.

Fig. 2. Posterior scalp-muscles of *Megaderma lyra*.

*a*. occipito-pollicalis.
*b*. retrahens aurem superior.
*c*. retrahens inferior.
*d*. occipito-frontalis, hinder belly.
*e*. splenius capitis.

Fig. 3. Facial muscles of *Macroglossus minimus*.

*a*. occipito-frontalis.
*b*. procerus nasi.
*c*. dilator naris.
*d*. orbicularis palpebrarum.
*e*. attrahens aurem.
*f*. levator labii superioris.
*g*. orbicularis oris.
*h*. zygomaticus.
*i*. buccinator.
*j*. depressor labii inferioris.
*k*. masseter.
*l*. parotid gland.

Fig. 4. Cutaneous muscles of *Eleutherura marginata*, lateral aspect.

*a*. occipito-pollicalis.
*b*. platysma superior.
*c*. platysma medius.
*d*. platysma inferior.
*e*. pectoralis major.

Fig. 5. Facial muscles of *Megaderma lyra*.

*a*. occipito-pollicalis.
*b*. spinal accessory nerve.
*c*. sterno-mastoid.
*d*. masseter.
*e*. auriculo-angularis.
*f*. attrahens aurem.
*g*. frontalis.
*h*. orbicularis palpebrarum.
*i*. levator labii superioris.
*j*. levator alæ nasi.
*k*. orbicularis oris.
*l*. depressor anguli oris.
*m*. procerus nasi.
*n*. nose-leaf.

Fig. 6. Facial muscles of *Vampyrops vittatus*.

*a*. lower slip of retrahens aurem.
*b*. upper slip of ditto.
*c*. attollens aurem.
*d*. occipito-frontalis.
*e*. procerus nasi.
*f*. corrugator supercilii.
*g*. orbicularis palpebrarum.
*h*. levator labii superioris.
*i*. levator anguli oris.
*j*. zygomaticus.
*k*. orbicularis oris.
*l*. masseter.
*m*. depressor labii inferioris.

Fig. 7. Posterior deep neck-muscles of *Macroglossus minimus*.

*a*. origin of occipito-frontalis.
*b*. retrahens aurem.
*c*. rectus capitis posticus major.
*d*, *e*. obliquus inferior capitis.
*f*. obliquus superior capitis.
*g*. rectus lateralis.
*h*. rectus capitis posticus minor.
*i*. grain of shot in intermuscular space.
*j*. intertransversalis.

Fig. 8. Cervical muscles of *Megaderma lyra*.

*a*. masseter.
*b*. mento-hyoidean.
*c*. digastric, anterior belly.
*d*. inscription in digastric.
*e*. parotid.
*f*. sterno-mastoid.
*g*. omo-hyoid.
*h*. pectoralis major.
*i*. sterno-hyoid.
*j*. trachea.

Fig. 9. Superficial dorsal muscles of *Megaderma lyra*.

*a*. splenius.
*b*. trapezius superior.
*c*. deltoideus acromialis.
*d*. acromion.
*e*. rhomboideus.
*f*. trapezius inferior.
*g*. deltoideus scapularis.
*h*. teres major.
*i*. latissimus dorsi.
*j*. dorsi epitrochlearis.
*k*. triceps longus anterior.
*l*. triceps longus posterior.

Fig. 10. Superficial shoulder-muscles of *Vampyrops vittatus*.

*a*. deltoideus acromialis.
*b*. acromion.
*c*. supraspinatus.
*d*. deltoideus scapularis.
*e*. teres major.
*f*. triceps longus.

Fig. 11. Second layer of shoulder-muscles in the same, *a*, *b*, *c*, *d*, *e*, *f* as in the last.

*g*. humerus.
*h*. split insertion of the scapular deltoid.

Fig. 12. Third layer of shoulder-muscles in *Vampyrops vittatus*.

*a*, *b*, *c*, *d* as in figs. 10 & 11.
*e*. insertion of the scapular deltoid.
*f*. circumflex humeri nerve supplying the acromial deltoid.
*g*. filament of the same nerve supplying the scapular deltoid.
*h*. infraspinatus.
*i*. teres minor.
*j*. triceps longus.
*k*. origin of teres major.

Fig. 13. Anterior arm-muscles in *Macroglossus minimus*.

*a*. subclavius.
*b*. subscapularis.

*c.* subscapulo-humeral.
*d.* coraco-brachialis.
*e.* coracoid head of biceps.
*f.* biceps, belly.
*g*, *g'*. long head of biceps.

Fig. 14. Long head of front of forearm of *Vampyrops vittatus*.

*a.* flexor carpi radialis.
*b.* palmaris longus.
*c.* flexor digitorum.
*d.* flexor carpi ulnaris.
*e.* process of os magnum.
*f.* flexor brevis minimi digiti.
*g.* interossei of annularis.
*h.* ulnar interosseus of medius.
*i.* radial interosseus of medius.
*j.* ulnar interosseus of index.
*k.* adductor pollicis.
*l.* abductor pollicis.
*m.* flexor brevis pollicis.

## PLATE XIV.

Fig. 1. Muscles of front of forearm in *Macroglossus minimus*.

*a.* supinator longus.
*b.* pronator teres.
*c.* flexor carpi radialis.
*d.* flexor digitorum.
*e.* flexor carpi ulnaris.
*f.* abductor minimi digiti.
*g.* radial interosseus of minimus.
*h.* radial interosseus of annularis.
*i.* radial interosseus of medius.
*j.* ulnar interosseus of medius.
*k.* ulnar interosseus of index.
*l.* palmaris longus.

Fig. 2. Diagram of digital tendons in *Vampyrops vittatus*.

*a.* palmaris longus.
*b.* its radial tendon to pollex.
*c.* its ulnar tendon to pollex.
*d.* tendon to index.
*e.* tendon to medius.
*f.* tendon of flexor digitorum to pollex.
*g.* tendon of same to medius.
*h.* flexor digitorum.
*i.* annular ligament.

Fig. 3. Diagram of flexor tendons in *Macroglossus minimus*.

*a.* flexor carpi radialis.
*b.* its tendon to carpus.
*c.* its tendon to index.
*d.* palmaris longus.
*e.* its tendon to pollex.
*f.* its tendon to index.
*g.* flexor digitorum.
*h.* its tendon to pollex.
*i.* tendon to index.
*j.* tendon to interosseus of medius.
*k.* flexor carpi ulnaris.
*l.* its tendon to fourth metacarpal.
*m.* tendon to fifth metacarpal.
*n.* tendon to abductor minimi digiti.

Fig. 4. Tendons on back of wrist in *Cynonycteris amplexicaudatus*.

*a.* extensor carpi ulnaris.
*b.* extensor communis digitorum.
*c.* tendon to minimus.
*d.* tendon to annularis.
*e.* tendon to medius.
*f.* extensor ossis metacarpi pollicis.
*g.* extensor pollicis longus.
*h.* extensor pollicis et indicis.
*i.* extensor indicis.
*j.* extensores carpi radiales.
*k.* tendon of brevior.
*l.* tendon of longior.

Fig. 5. Antebrachial muscles of *Noctulina altivolans*.

*a*. biceps tendon.
*b*. humero-cutaneus.
*c*. supinator longus.
*d*. pronator teres.
*e*. flexor digitorum.
*f*. flexor carpi ulnaris.
*g*. abductor pollicis.
*h*. flexor brevis pollicis.
*i*. opponens indicis.
*j*. two interossei of medius.
*k*. interosseus of annularis.
*l*. interosseus of minimus.

Fig. 6. Deep abdominal muscles of *Megaderma lyra*.

*a*. psoas parvus.
*b*. posas magnus.
*c*. quadratus lumborum.
*d*. obturator externus.
*e*. pectineus, origin of.
*f*. caudo-femoralis.
*g*. extensor cruris.
*h*. diaphragm.

Fig. 7. Muscles of the thigh in *Macroglossus minimus*.

*a*, *b*, *c* as in fig. 6.
*d*. iliacus.
*e*. gracilis.
*f*. hamstrings.
*g*. rectus femoris.

Fig. 8. Muscles of the thigh in *Macroglossus minimus*.

*a*, *b*, *d*, *g* as in fig. 7.
*f*. semimembranosus.
*h*. semitendinosus.
*i*. pectineus.
*j*. adductor brevis.
*k*. adductor magnus.

Fig. 9. Femoral muscles of *Macroglossus minimus*.

*a*, *b*, *d*, *g*, *k* as in fig. 8.
*l*. quadratus femoris.
*m*. obturator externus.

Fig. 10. Gluteal muscles of *Macroglossus minimus*.

*a*. gluteus medius.
*b*. iliacus.
*c*. gluteus quartus.
*d*. rectus femoris.
*e*. caudo-femoralis superior.
*f*. ditto inferior.
*g*. semitendinosus.
*h*. semimembranosus.
*i*. dorsum ilii.
*j*. sacro-sciatic foramen.
*k*. tuber ischii.

Fig. 11. Anterior femoral muscles of *Cephalotes Pallasii*.

*a*. iliacus.
*b*. psoas magnus.
*c*. psoas parvus.
*d*, *d'*. gracilis.
*e*. rectus femoris.
*f*. adductor magnus.
*g*. adductor brevis.
*h*. slip from pectineal point to the insertion of the gracilis; perhaps a sartorius?
*i*. pectineus.
*j*. semimembranosus.
*k*. semitendinosus.

Fig. 12. Thigh-muscles of *Noctulina altivolans*.

*a*. gracilis.
*b*. pectineus.
*c*, *e*. iliacus.
*f*. pectineus.

*d, g.* rectus femoris.
*h.* quadratus femoris.
*i.* adductor brevis.
*i.* semimembranosus.
*j.* semitendinosus.

Fig. 13. Extensor aspect of femur of *Macroglossus minimus.*

*a.* dorsum of ilium.
*b.* iliacus.
*c.* pyriformis.
*d.* rectus femoris.
*e.* femoral head of the extensor cruris (cruræus and vasti in one).

Fig. 14. Gluteal and other muscles of *Noctulina altivolans.*

*a.* gluteus medius.
*b.* iliacus.
*c.* rectus femoris.
*d.* femoral head of extensor cruris.
*e.* caudo-femoralis.
*f.* semitendinosus.
*g.* semimembranosus.
*h.* gluteus maximus.
*i.* belly of extensor cruris.
*j.* gastrocnemius.
*k.* flexor digitorum longus.
*l.* peronæi muscles.
*m.* elevator of the styliform bone.
*n.* depressor of the styliform bone.
*o.* extensor brevis digitorum.
*p.* peroneal tendon.

Fig. 15. Gluteal muscles of *Macroglossus minimus.*

*a.* gluteus maximus.
*b.* iliacus.
*c.* semitendinosus.
*d.* semimembranosus.

Fig. 16. Crural muscles of *Vampyrops vittatus.*

*a.* gastrocnemius.
*b.* fibular head.
*c.* tibial head with sesamoid bone.
*d.* flexor digitorum longus.
*e.* flexor hallucis longus.
*f.* depressor of the styliform bone.
*g.* flexor brevis digitorum.

Fig. 17. Crural muscles of *Vampyrops vittatus*, deep flexors.

*a.* flexor tibialis digitorum.
*b.* popliteus, rudimental.
*c.* flexor hallucis longus.
*d.* tibialis posticus.
*e.* tendon of tibialis posticus.
*g.* depressor of the styliform bone.
*h.* tendon of the flexor hallucis.
*i.* abductor minimi digiti.
*j.* tibial lumbricalis of minimus.
*k.* fibular lumbricalis of annularis.
*l.* tibial lumbricalis of annularis.
*m.* tibial lumbricalis of medius.
*n.* fibular lumbricalis of index.
*o.* abductor hallucis.

Fig. 18. Diagram of flexor tendons and lumbricalis in *Vampyrops.*

*a.* flexor digitorum.
*b.* flexor hallucis.
*c.* flexor hallucis brevis.
*d.* tendon of fl. digitorum to hallux.
*e.* tendon of same to index.
*f.* tendon of same to medius.
*g.* tendon of same to annularis.
*h.* tendon of same to minimus.
*i.* fibular lumbricalis of minimus.
*j.* tendon of flexor hallucis for annularis.
*k.* ditto for medius.
*l.* ditto for index.
*m.* ditto for hallux.
*n.* fibular lumbricalis for annularis.
*o.* tibial lumbricalis for annularis.
*p.* fibular lumbricalis for medius.

*q*. tibial ditto.
*r*. fibular lumbricalis for index.
*s*. tibial ditto.
*t*. continuation of ditto.
*u*. tendons to minimus.
*v*. tendons to annularis.
*w*. tendons to medius.
*x*. tendons to index.
*y*. tendons to pollex.

Fig. 19. Plantar muscles of *Macroglossus minimus*.

*a*. tibia.
*b*. fibula.
*c*. os calcis.
*d*. cuboid bone.
*e*. abductor ossis metatarsi minimi digiti.
*f*. abductor minimi digiti.
*g*. transversus pedis posterior.
*h*. transversus anterior.
*i*. abductor hallucis.
*j*. flexor brevis hallucis.
*k*. rudimental opponens.
*l*. tibial interosseus of index.
*m*. fibular of ditto.
*n*. tibial of medius.
*o*. fibular of ditto.
*p*. tibial of annularis.
*q*. fibular of ditto.
*r*. tibial of minimus.

## PLATE XV.

Fig. 1. Body-muscles of *Cephalotes Pallasii*, front view.

*a*. frontalis.
*b*. procerus nasi.
*c*. nasal head of levator labii superioris.
*d*. angular head of ditto.
*e*. levator anguli oris.
*f*. orbicularis palpebrarum.
*g*. zygomaticus minor.
*h*. auriculo-angularis.
*i*. attrahens aurem.
*j*. masseter.
*k*. attollens aurem.
*l*. sterno-mastoid, superficial.
*m*. sterno-mastoid, deep layer.
*n*. cleido-mastoid.
*o*. splenius.
*p*. sterno-hyoid.
*q*. occipito-pollicalis.
*r*. omo-hyoid.
*s*. pectoralis major.
*t*. subclavius.
*u*. serratus anticus.
*v*. pectoralis quartus.
*w*. subscapularis.
*x*. biceps flexor cubiti.
*y*. triceps extensor.
*z*. coraco-brachialis.
*α*. serratus magnus.
*β*. external oblique.
*γ*. rectus abdominis.
*δ*. internal oblique.
*ε*. iliacus.
*ζ*. rectus femoris.
*η*. pectineus.
*θ*. hamstrings.
*ι*. adductor brevis.
*κ*. epicoracoid.
*λ*. hypogastric muscular deficiency above the pubes and between the recti.

Fig. 2. Body-muscles of *Cephalotes Pallasii*, back view.

*a*. occipitalis.
*b*. retrahens aurem.
*c*. occipito-pollicalis.
*d*. splenius.
*e*. slip from occipito-pollicalis to retrahens aurem.
*f*. nuchal accessory slip to occipito-pollicalis.
*g*. levator claviculæ.
*h*. levator anguli scapulæ.
*i*. supraspinatus.
*j*. rhomboideus.
*k*. serratus magnus.
*l*. deltoideus acromialis.
*m*. deltoideus scapularis.
*n*. teres major.
*o*. triceps.
*p*. biceps.
*q*. latissimus dorsi.
*r*. erectores spinæ.
*s*. gluteus maximus.

## PLATE XVI.

Fig. 1. Cutaneous muscles of *Pteromys volans*.

*a*. transversus nuchæ.
*b*, *c*. jugo-pollicalis.
*d*. pectoralis major.
*e*. styliform bone of carpus.
*f*. carpo-tarsalis.
*g*. carpopatagialis.
*h*. coracopatagial fibres.
*i*. coraconotal.
*k*. ilio-cutaneus.

Fig. 2. Cutaneous neck-muscles of *Pteromys*.

*a*. origin of jugo-pollicalis.
*b*. jugo-pollicalis.
*c*. transversus nuchæ.

Fig. 3. Superficial thigh-muscles of *Galeopithecus volitans*.

*a*. reflected integument.
*b*. external oblique of abdomen.
*c*. iliac crest.
*d*. gracilis.
*e*. sartorius.
*f*. iliacus.
*g*. rectus.

Fig. 4. Thigh-muscles of *Pteromys*, back view.

*a*. tensor vaginæ femoris.
*b*. gluteus maximus.
*c*. rectus and vastus externus.
*d*. agitator caudæ.
*e*. caudal origin of semitendinosus.
*f*. bicipiti accessorius.
*g*. biceps.
*h*. gastrocnemius externus.

Fig. 5. Thigh-muscles of *Pteromys*, front view.

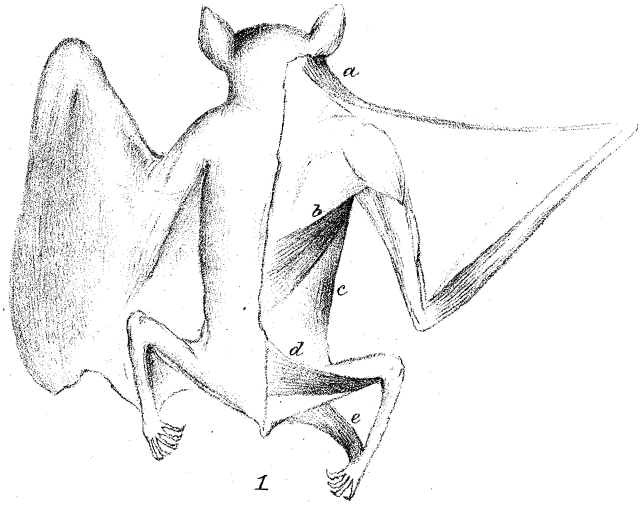
*a*. iliacus.
*b*. psoas magnus.
*c*. psoas parvus tendon.
*d*. tensor vaginæ femoris.
*e*. vastus internus.
*f*. adductor brevis.
*g*. condyloid part of the adductor magnus.
*h*. semimembranosus.
*i*. gracilis.
*j*. semitendinosus, ischiatic head.
*k*. caudal origin.
*l*. rectus femoris.
*m*. edge of adductor longus.
*n*. pectineus.

Fig. 6. Posterior shoulder-muscles of *Pteromys*.

*a*. supraspinatus.
*b*. occipital rhomboid.
*c*. scapular deltoid.
*d*. acromion deltoid.
*e*. triceps externus.
*f*. triceps longus.
*g*. dorsi epitrochlear.
*h*. teres major.
*i*. latissimus dorsi.
*j*. brachialis anticus.
*k*. biceps.
*l*. supinator longus.
*m*. muscles from external condyle.

Fig. 7. Internal surface of arm-muscles of the same.

*a*. pectoralis minor.
*b*. subscapularis.
*c*. dorsi epitrochlear.
*d*. triceps longus.
*e*. triceps internus.
*f*. coraco-brachialis longus.
*g*. coracoid head of biceps.
*h*. long head of biceps.
*i*. coraco-brachialis brevis.
*j*. insertion of great pectoral.



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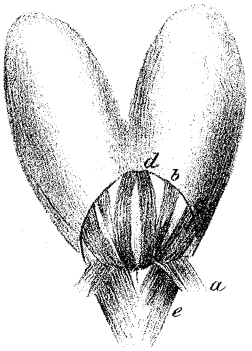

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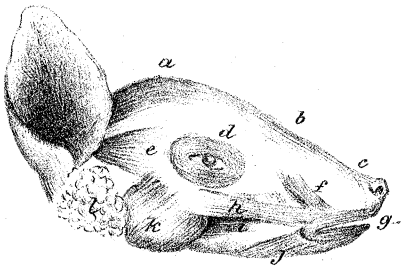

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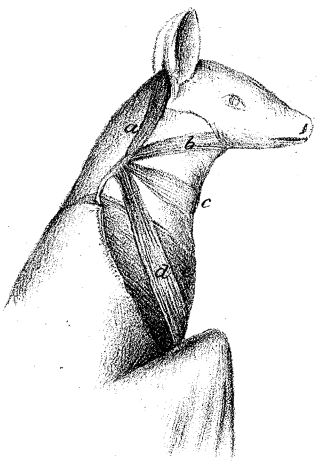

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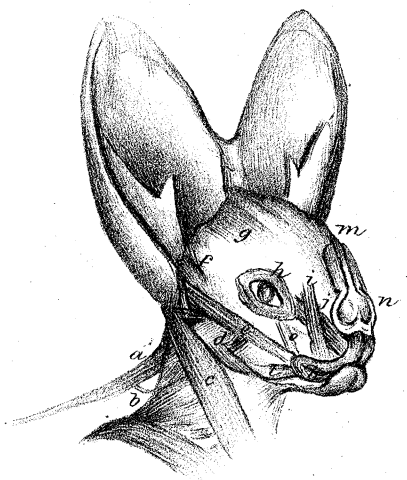

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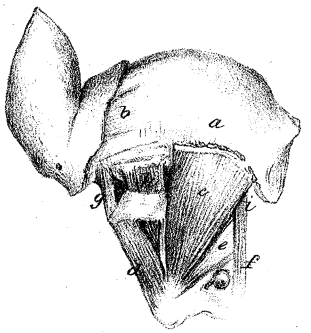

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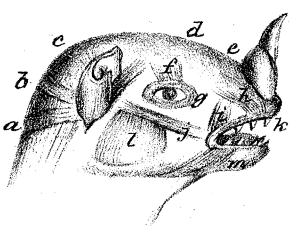

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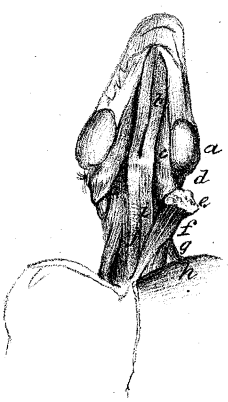

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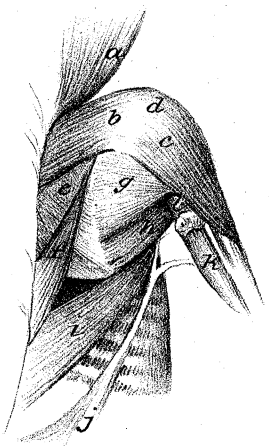

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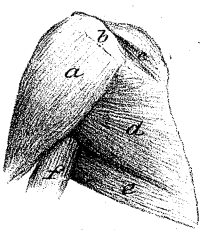

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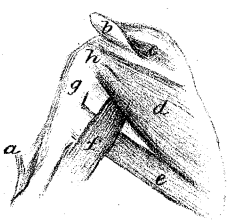

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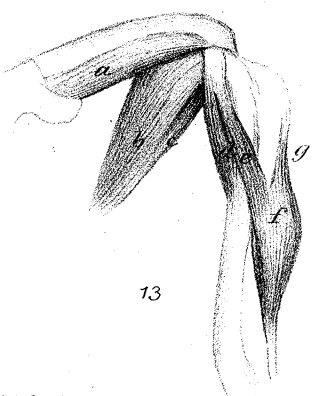

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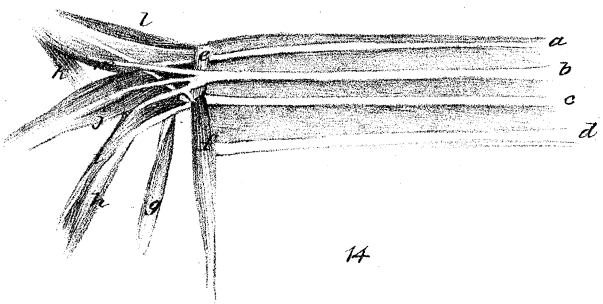

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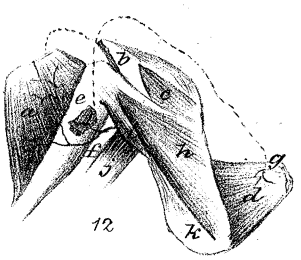

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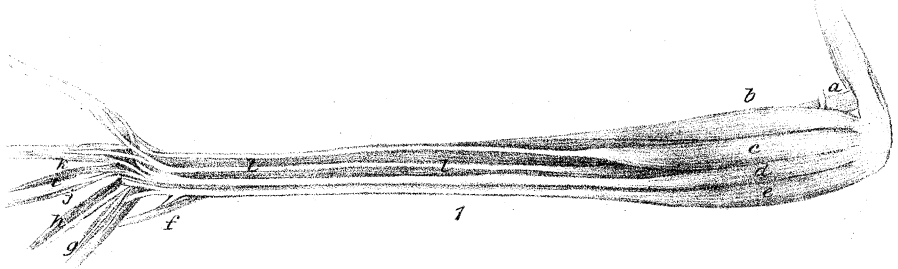
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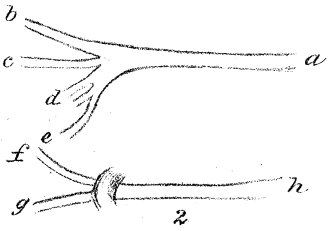
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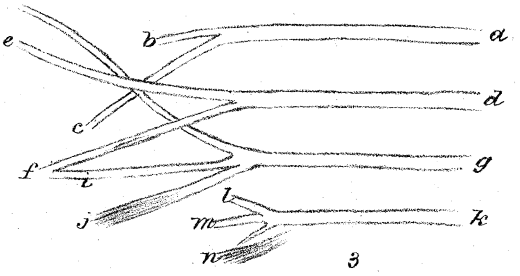
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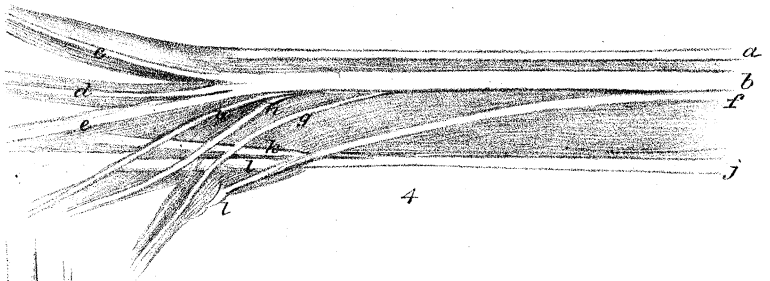
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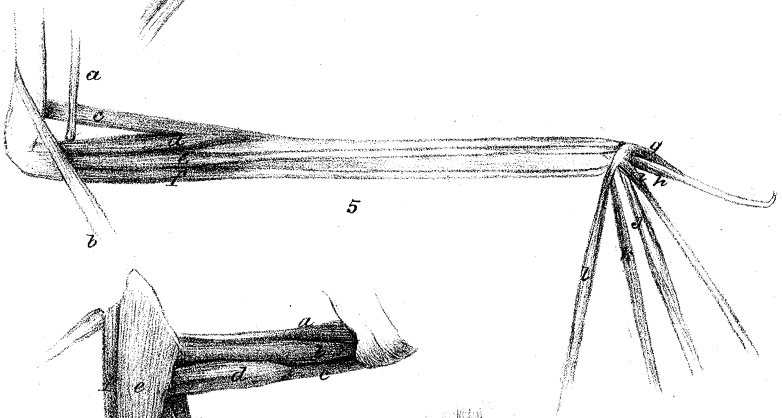
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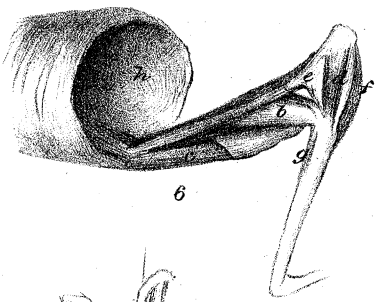
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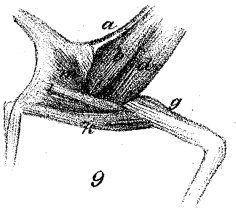
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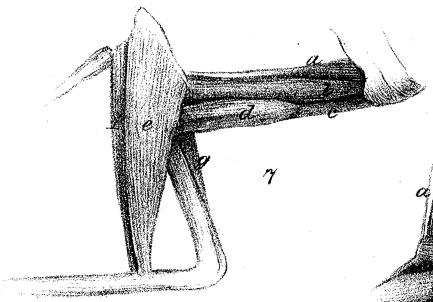
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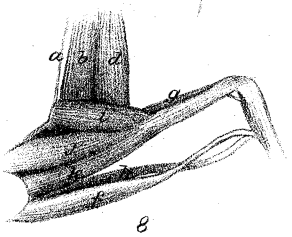
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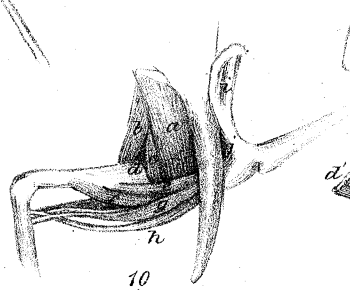
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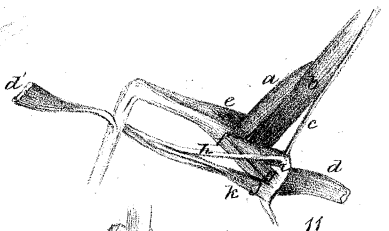
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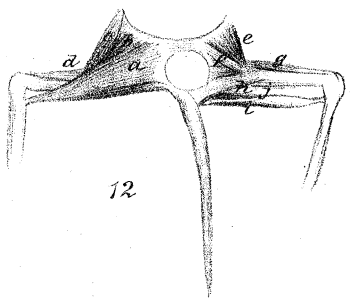
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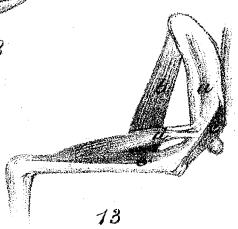
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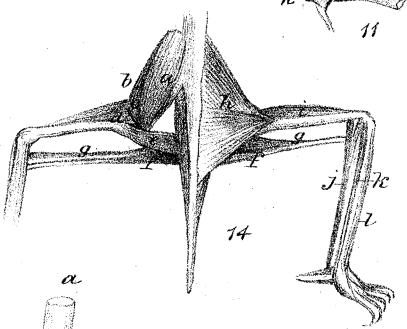
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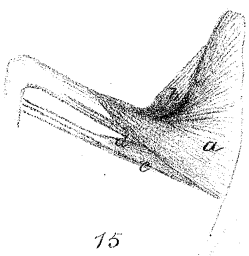
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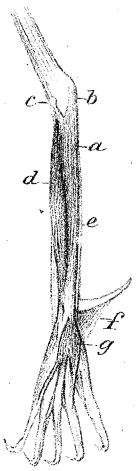
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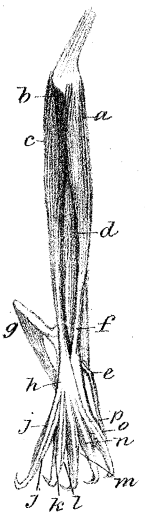
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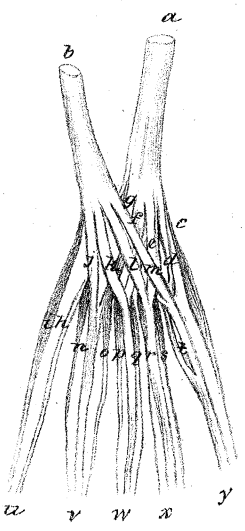
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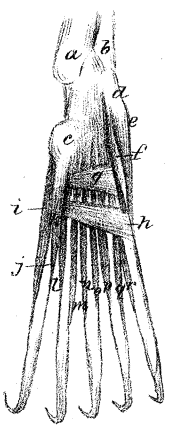
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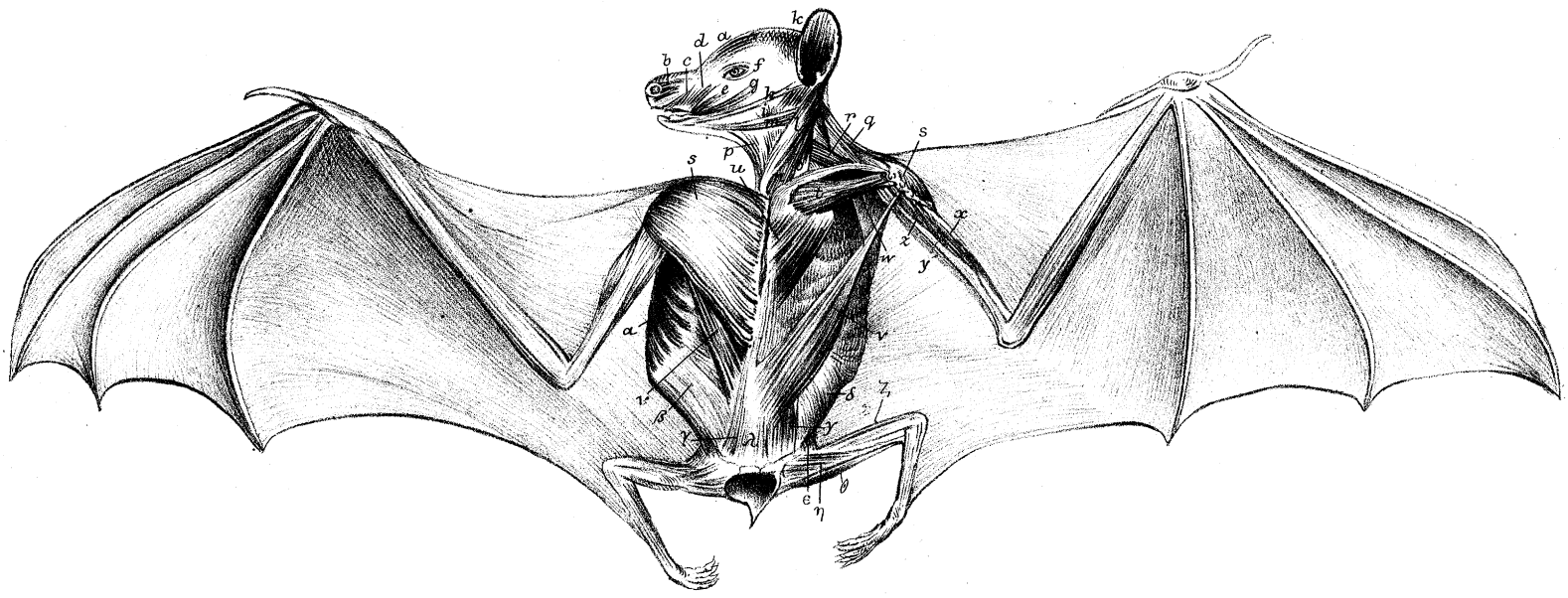


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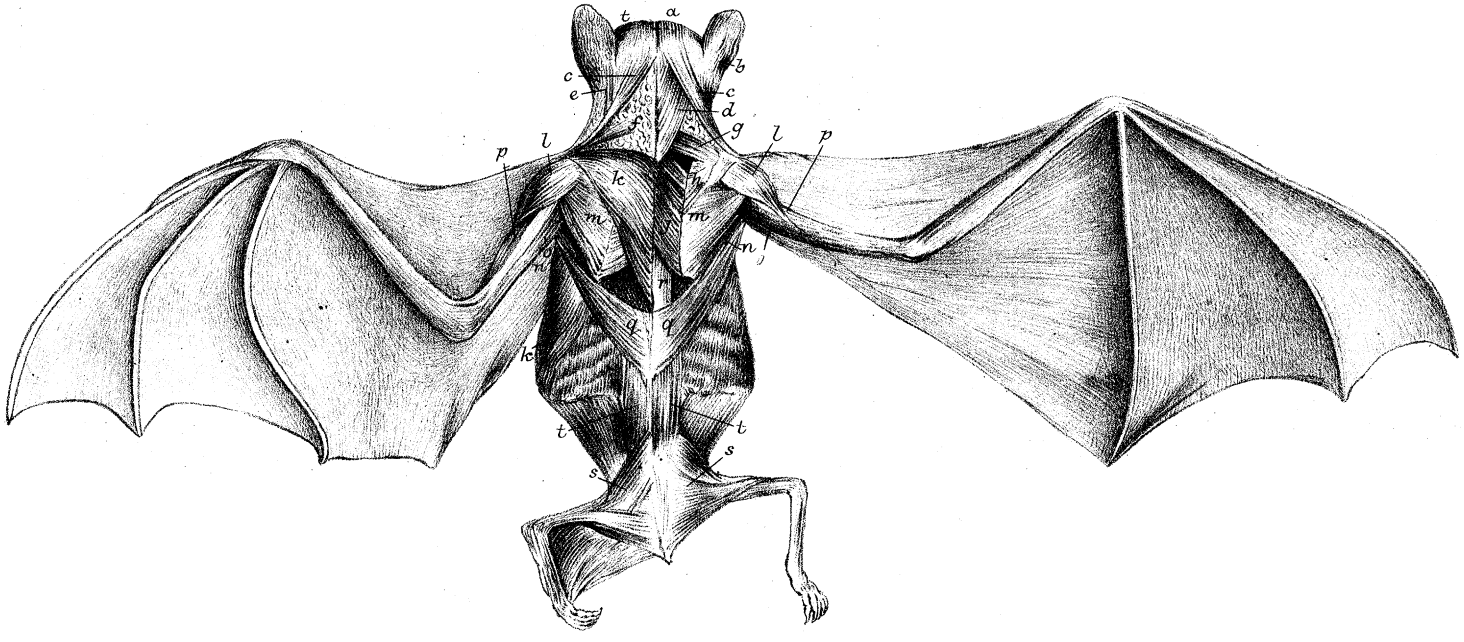

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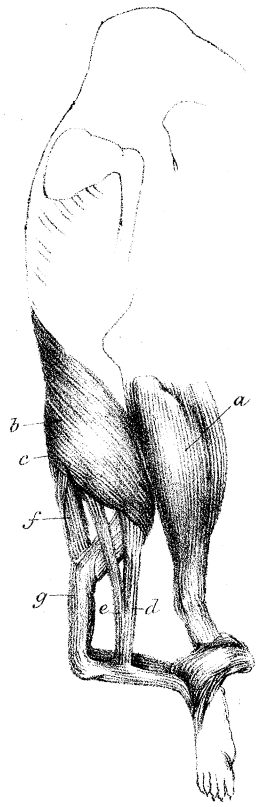


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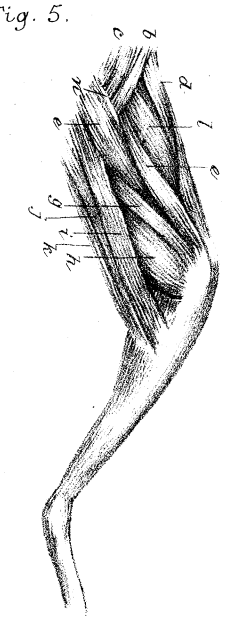



Fig. 6.

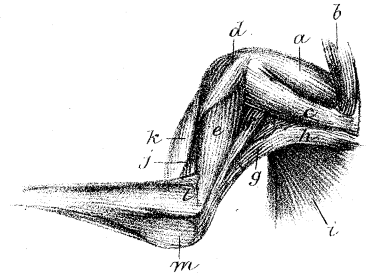



Fig. 4.

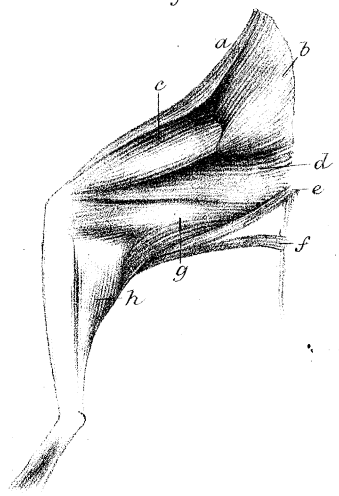
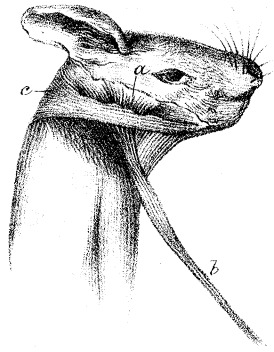



Fig. 2.



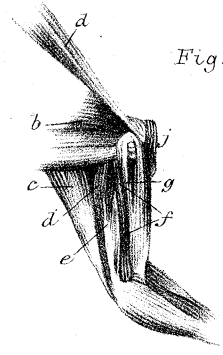




Fig. 7.

Fig. 1.

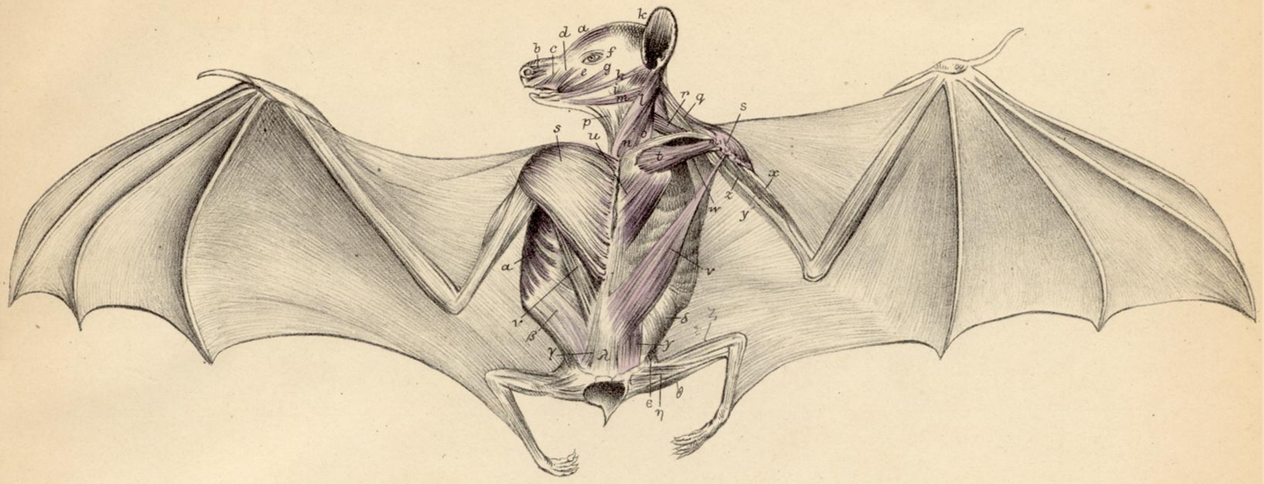
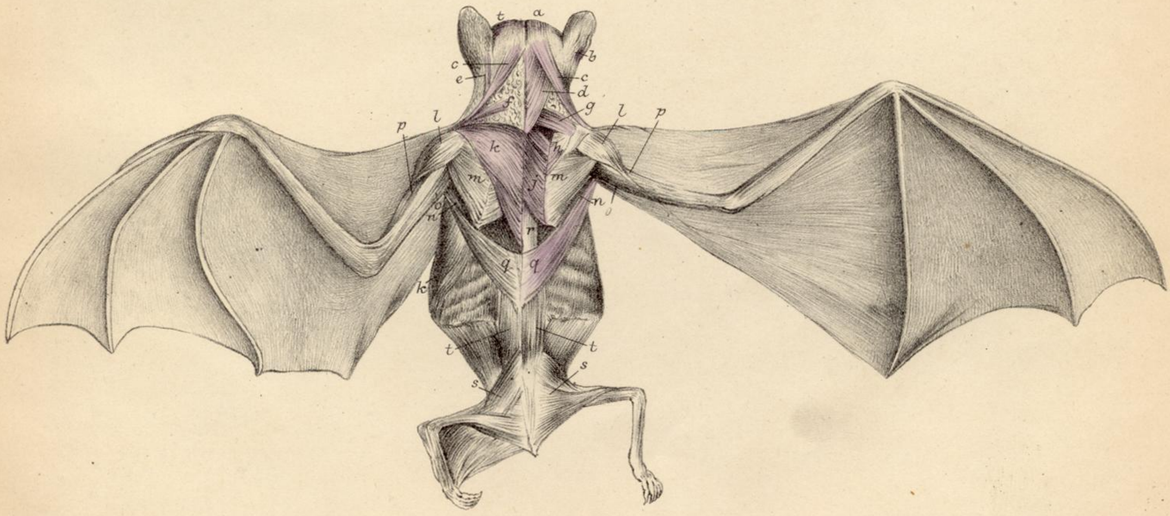


Fig. 2.



## PLATE XV.

Fig. 1. Body-muscles of *Cephalotes Pallasii*, front view.

*a.* frontalis.
*b.* procerus nasi.
*c.* nasal head of levator labii superioris.
*d.* angular head of ditto.
*e.* levator anguli oris.
*f.* orbicularis palpebrarum.
*g.* zygomaticus minor.
*h.* auriculo-angularis.
*i.* attrahens aurem.
*j.* masseter.
*k.* attollens aurem.
*l.* sterno-mastoid, superficial.
*m.* sterno-mastoid, deep layer.
*n.* cleido-mastoid.
*o.* splenius.
*p.* sterno-hyoid.
*q.* occipito-pollicalis.
*r.* omo-hyoid.
*s.* pectoralis major.
*t.* subclavius.
*u.* serratus anticus.
*v.* pectoralis quartus.
*w.* subscapularis.
*x.* biceps flexor cubiti.
*y.* triceps extensor.
*z.* coraco-brachialis.
*α.* serratus magnus.
*β.* external oblique.
*γ.* rectus abdominis.
*δ.* internal oblique.
*ε.* iliacus.
*ζ.* rectus femoris.
*η.* pectineus.
*θ.* hamstrings.
*ι.* adductor brevis.
*κ.* epicoracoid.
*λ.* hypogastric muscular deficiency above the pubes and between the recti.

Fig. 2. Body-muscles of *Cephalotes Pallasii*, back view.

*a.* occipitalis.
*b.* retrahens aurem.
*c.* occipito-pollicalis.
*d.* splenius.
*e.* slip from occipito-pollicalis to retrahens aurem.
*f.* nuchal accessory slip to occipito-pollicalis.
*g.* levator claviculæ.
*h.* levator anguli scapulæ.
*i.* supraspinatus.
*j.* rhomboideus.
*k.* serratus magnus.
*l.* deltoideus acromialis.
*m.* deltoideus scapularis.
*n.* teres major.
*o.* triceps.
*p.* biceps.
*q.* latissimus dorsi.
*r.* erectores spinæ.
*s.* gluteus maximus.