

ON THE HOMOLOGIES OF THE LONG FLEXOR  
MUSCLES OF THE FEET OF MAMMALIA, WITH  
REMARKS ON THE VALUE OF THEIR LEADING  
MODIFICATIONS IN CLASSIFICATION. By G. E.  
DOBSON, M.A., M.B. (PLATES IV., V., VI.)

WHILE studying the anatomy of the Insectivora I was much struck with the many modifications of form and arrangement presented by the long flexors of the feet in different species, and careful examinations of the nature of these modifications, and comparisons with those observable in the species of other Mammalian orders (which I have fortunately been enabled to carry out with considerable detail<sup>1</sup>) have demonstrated forcibly that the homologies of these muscles are very imperfectly understood by anatomists generally.<sup>2</sup>

In most species of mammals three long flexor muscles form the deep layer on the posterior aspect of the leg; these are—

1. *Flexor digitorum fibularis* = *Flexor hallucis longus* (Human Anatomy).

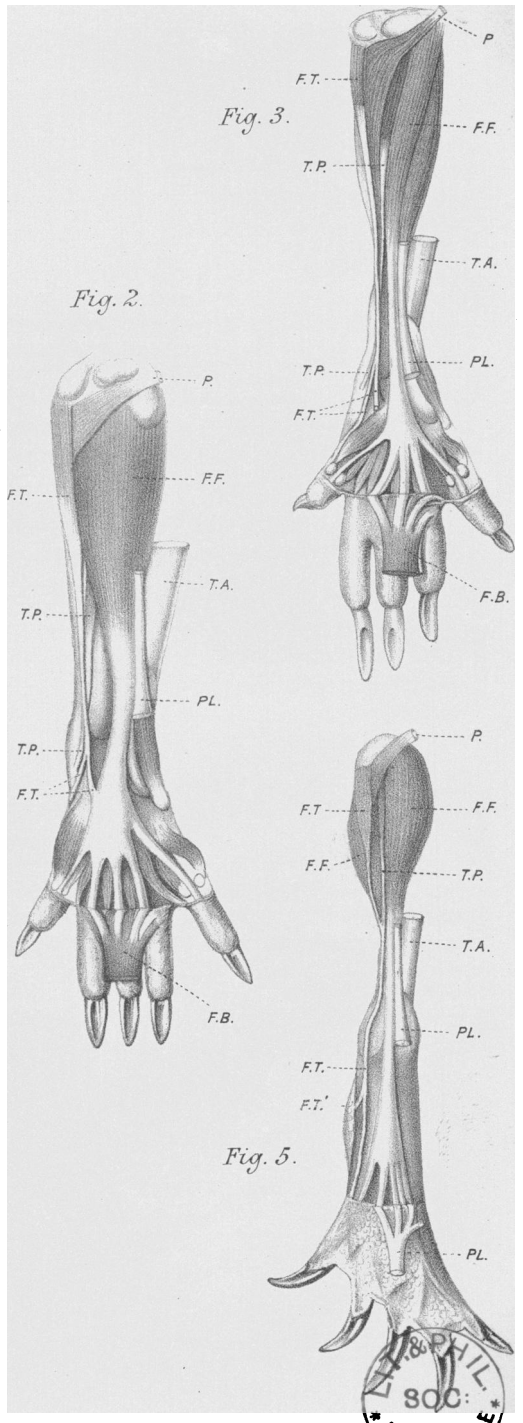
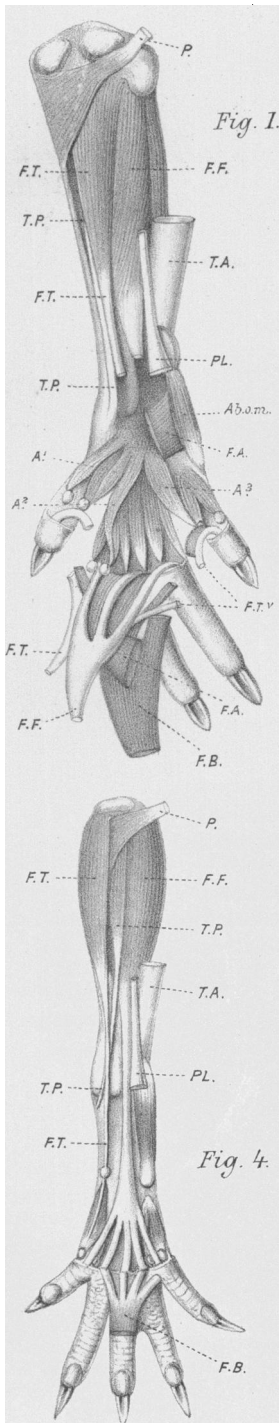
2. *Flexor digitorum tibialis* = *Flexor digitorum longus* (Human Anatomy).

3. *Tibialis posticus*.

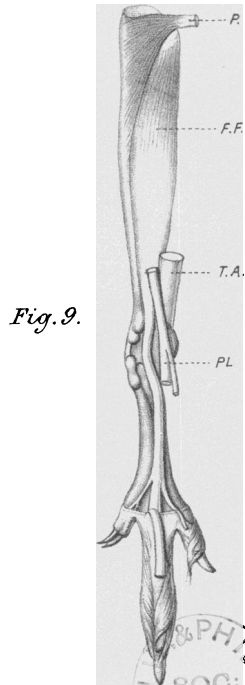
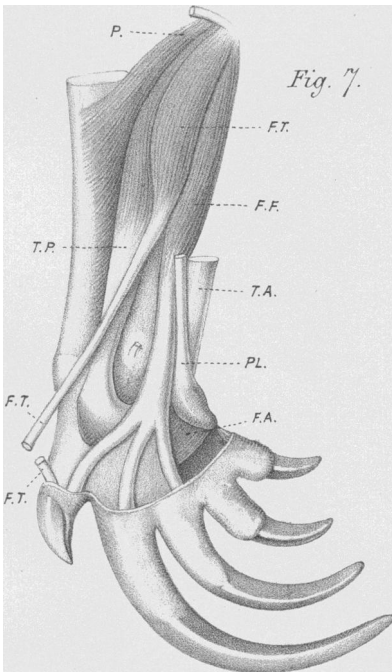
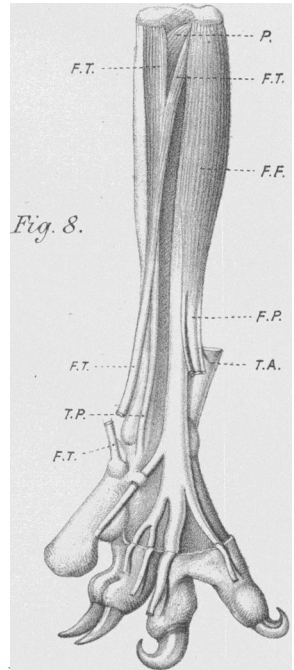
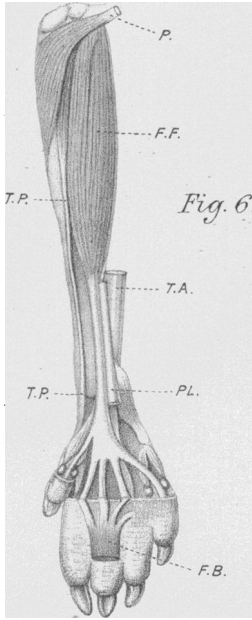
These three muscles are represented by their homologues in most mammals; the *flexor fibularis* exists in all, and exhibits but slight modifications, but the other two are subject to much variability, and may be severally or collectively absent; the *flexor tibialis* especially varies very considerably within certain limits, so much so, indeed, that not being recognised under its altered conditions, its apparent or real disappearance has been

<sup>1</sup> Owing chiefly to the kindness of Prof. W. H. Flower, F.R.S., and Mr. W. A. Forbes, Prosector to the Zoological Society, who afforded me every opportunity for the examination of the valuable series of specimens in their charge.

<sup>2</sup> At the commencement of his paper "On the Disposition of the Deep Plantar Tendons in Different Birds," the late Professor A. H. Garrod remarks:—"The arrangement of the tendons in the palm of the hand and the sole of the foot among the Mammalia is a subject of great intricacy, as may be inferred from the comparison of the dissections of different animals."—*Proc. Zool. Soc.*, 1875, p. 339.



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attempted to be explained by anatomists by supposing it to have undergone fusion with the *flexor fibularis*, thus forming a *flexor digitorum communis*,<sup>1</sup> while the differentiated muscle (unknown as such) has been described as part of the *tibialis posticus*<sup>2</sup> or referred to under the names of *tibialis posticus accessorius*,<sup>3</sup> *secundus*, or *internus*.<sup>4</sup> It is the chief object of this paper to demonstrate the true relations of this muscle, and to show that neither of the above supposed conditions really obtain in any of the species in which they have been described, nor probably in any species of mammal.

Of all the orders of Mammalia the Insectivora present by far the greatest amount of variety in the arrangement of the long flexors of the feet, and there is scarcely any modification of these muscles in the legs or feet of the species of other orders, which is not either represented by or capable of being derived from corresponding structures in the species of this small group, another indication added to the many of the central position of this order among those of the higher mammals.

<sup>1</sup> "The *flexor longus digitorum pedis* and the *flexor longus pollicis* are united," Owen, "Anat. of *Dasyypus sex-cinctus*," *Proc. Zool. Soc.*, 1832, p. 138. "*Flexor hallucis longus* pariter cum *flexore digitorum longo*," Hyrtl, *Chlamydophori truncati* Anat., *Denkschr. Akad. Wissensch.*, Wien., 1855, p. 41. "*Flexor digitorum longus*, in the Wombat, is in reality a compound of two parts, the *flexor digitorum* and the *flexor hallucis*. In *Macropus giganteus*, *M. bennettii*, *Sarcophilus*, the Opossum, and Phalanger, these muscles are similarly fused," Macalister, *Ann. Mag. Nat. Hist.*, v. (1870). "The *flexor hallucis* and *flexor perforans* have a common tendon" (in *Erinaceus*), Huxley, *Anat. Vertebr. Anim.*, p. 446 (1871). "*Flexor hallucis longus* and *flexor communis digitorum* are conjoined," Murie, *Trans. Linnean Soc.*, xxx. p. 101 (1874). "The *flexor longus digitorum* and the *flexor hallucis* are inseparable" (in *Phascolarctos cinereus*), Young, *Jour. Anat. Phys.*, xvi. p. 237 (1882), and in the writings of these and other anatomists elsewhere.

<sup>2</sup> "Fasciculus separated from the *tibialis posticus*," Owen, *l.c.*; Cuvier, *Myologie*, pl. 268; Schulze, *Zeitschr. für Wissensch. Zoologie*, Leipzig, 1867, p. 13.

<sup>3</sup> "Infra Poplitei insertionem, novus exsurgit musculus, qui Tibialem posticum viæ comitem laborisque socium legit. Retro malleolum internum in teretem fatiscit tendinem, qui margini pedis externo appropinquat, et ad basin ossiculi illius depressi finem assequitur, quod metatarso hallucis interne adjacet. *Tibiale posticum* accessorium non invite nominarem."—Hyrtl, "Chlamydophori truncati Myologia," *l.c.*

<sup>4</sup> Galton, *Trans. Linnean Soc.*, xxx. p. 558 (1869); Huxley, *l.c.*; Murie, *l.c.*; Macalister, *Introd. Syst. Zool. Morph. Vert. Anim.*, p. 304 (1878); Dobson, *Monograph of the Insectivora, Systematic and Anatomical*, pp. 34 and 57 (1882); Young, *l.c.*

We may, therefore, take the leading modifications of these muscles in Insectivora as a convenient basis for comparison, and, having described and figured them, pass on to the consideration of the principal varieties of form and arrangement presented by corresponding parts in the species of other orders.<sup>1</sup>

In *Centetes ecaudatus*, the common ground-hog of Madagascar, and the largest of living Insectivora, we have what may be termed the typical Mammalian leg and foot (Plate IV., fig. 1), for out of it might, by modification, be constructed the corresponding parts of the hinder extremity of any other known mammal. In the leg we find a distinct tibia and fibula, a tarsus of seven bones, five metatarsals, a hallux with two, and four digits with three, phalanges each. Of the muscles attached to these bones there are, besides extensors and the superficial flexors of the foot entering into the formation of the tendo achillis, the following long and short flexors, and other muscles of the plantar surfaces:—

1. *Flexor digitorum fibularis* (*f. f.*) = *Flexor hallucis longus* (Human Anatomy).

2. *Flexor digitorum tibialis* (*f. t.*) = *Flexor digitorum longus* (Human Anatomy).

3. *Tibialis posticus* (*t. p.*).

4. *Flexor digitorum brevis* (*f. b.*).

5. *Flexor accessorius* (*f. a.*).

6. *Flexores digitorum breves vel interossei.*

7. *Adductores hallucis, indicis, minimi digiti a<sup>1</sup> a<sup>2</sup> a<sup>3</sup>.*

8. *Abductor ossis metatarsi minimi digiti* (*ab. o. m.*).

9. *Lumbricales.*

With the single exception of the first named, these muscles may, as already remarked, be severally or collectively absent until we find the limit reached in the marsupial genus *Hypsi-prymnus* (and probably in *Chæropus* also), where, omitting the muscles forming the tendo achillis, the long flexors are represented by the *flexor fibularis* only, and the plantar muscles are altogether wanting (see Plate V., fig. 9).

<sup>1</sup> The determination of the homologies by means of the nerve supply, so excellent a guide in many cases, cannot be successfully applied here, as all three muscles under consideration are supplied by the same nerve, namely, the posterior tibial.

In *Centetes ecaudatus*, however, they are severally and collectively well developed, and the long flexors have the following origins and connections:—

1. *Flexor fibularis* arises from the head and greater part of the posterior surface of the fibula, and, forming a moderately large tendon, passes into the foot through the deep groove on the inner side of the os calcis, becoming flattened out and connected with the superficial surface of the similarly expanded tendon of the *flexor tibialis*, before dividing into slips for the three middle toes (Plate IV. fig. 1, *f. f.*).

2. *Flexor tibialis* arises in close connection with the fibular flexor from the head of the fibula and part of the shaft of that bone, also from the interosseous membrane and part of the adjacent tibial margin, and, forming a more slender tendon, passes through a groove on the posterior surface of the internal malleolus, and, spreading out, becomes superficial to and united by its deep surface with the expanded tendon of the fibular flexor, but sends off, laterally, distinct slips for the hallux and fifth toe (Plate IV. fig. 1, *f. t.*).

Although the fibular and tibial flexors are, from their relative positions in the leg and foot, undoubtedly homologous with the *flexor hallucis longus* and *flexor digitorum longus*, respectively, of Human Anatomy, yet, as we have above-noted, their ultimate distribution in the foot is very different, that muscle which is homologous with the flexor of the hallux in man being here distributed to the three middle toes, whilst the homologue of the flexor digitorum supplies the hallux and fifth toe.

In the species of the allied genera *Hemicentetes* and *Ericulus* the relations of the tendons of these muscles in the foot are quite similar, and in those of *Oryzorictes* and *Microgale* (with united and rudimentary fibula), which belong to the same family, although the superimposed tendons are more closely united, the tendon for the hallux is still distinctly seen to be given off by the flexor digitorum.

3. *Tibialis posticus*, a much smaller muscle, arises in connection with the tibial flexor from the head of the fibula and interosseous membrane, but chiefly from the fibular side of the tibia under cover of the popliteus, and for a short distance below the lowest point of insertion of the latter muscle, forms a strong tendon

which passes down the postero-internal margin of the tibia, and, crossing the malleolus in a separate groove on the tibial side of the groove for the tendon of the *flexor tibialis*, is inserted into the scaphoid bone (Plate IV. fig. 1, *f. f.*).

Such are the origins and attachments of these three muscles in *Centetes ecaudatus*, with which we proceed to compare those of the corresponding parts in other mammals. Before describing the modifications in origin it will be necessary, however, to refer to the insertions in order to gain a clear idea of their homologies.

In Plate IV., figs. 2 and 3, representing the long flexor muscles on the posterior aspect of the leg and plantar surface of the foot of *Solenodon cubanus* and *Erinaceus europæus*, respectively, two distinct arrangements of the tendon of the *flexor tibialis* (*flexor digitorum longus*) are shown:—

- a. Tendon of the *flexor tibialis* united with that of the *flexor fibularis* (*flexor hallucis longus*) (fig. 2).
- b. Tendon of the *flexor tibialis* completely separated from that of the *flexor fibularis* (fig. 3).

These two conditions represent, as will be shown hereafter, the leading modifications of these muscles throughout the Mammalian series.

In Plate IV. fig. 2, *f. t.*, the tendon of the *flexor tibialis* (*flexor digitorum longus*) is seen passing through a groove on the tibial side of the internal malleolus accompanied by that of the *tibialis posticus*, which goes to its insertion into the scaphoid bone, while the former divides into two tendons, one of which is connected with the *flexor fibularis*, the other is inserted into the tibial side of the first metatarsal bone.

That the muscle marked *flexor tibialis* in fig. 2 is homologous with those similarly marked in figs. 1 and 3, admits of no doubt. In figs. 2 and 3 its origin is seen to be wholly removed from the fibula, but intermediate conditions are common in many species, and very well illustrated in the Marsupials in *Cuscus maculatus* and *Belideus flaviventer* (Plate V. fig. 8, *f. t.*). In *Erinaceus europæus* (Plate IV. fig. 3, *f. t.*), although the fibular slip from its tendon is no longer connected with that of the *flexor fibularis*, the tibial slip maintains the attachment to the first metatarsal bone as in *Solenodon cubanus* (fig. 2). In the Edentate *Orycteropus capensis* the *flexor tibialis* arises as in *Centetes ecaudatus*,

but divides after crossing the malleolus into two tendons, as in *Solenodon cubanus*, one going to the side of the *flexor fibularis*, the other to the sesamoid ossicle lying alongside the ento-cuneiform bone.<sup>1</sup> This condition is, therefore, intermediate between that of *C. ecaudatus* and *S. cubanus*. On the other hand, the fibular slip may alone remain connected with the superficial fascia and integument of the sole of the foot, as in *Gymnura rafflesii* and many species of *Erinaceus*.

In all the above cases the *tibialis posticus* is well developed; its tendon passes down generally under cover of that of the *flexor tibialis* when crossing the malleolus, and is inserted into the scaphoid or ento-cuneiform bones.

Having thus determined that this muscle, hitherto considered by anatomists as forming part of a double *tibialis posticus*, and named variously *tibialis posticus accessorius*, *secundus*, or *internus*, must really be looked upon as the representative of the tibial flexor of the toes (*flexor digitorum longus*) of *Centetes ecaudatus*, *Solenodon cubanus*, and many other species, we are in a position to consider its various leading modifications in origin and attachment in the species of Insectivora and other mammals.

*Flexor tibialis* may, by increase in the size of the *flexor fibularis*, have origin wholly from the tibia, as in *Gymnura rafflesii*, *Erinaceus europæus* (Plate IV. fig. 3), &c., or, as in *Condylura cristata* and *Myogale pyrenaica*, the fibular flexor may have such an extensive origin from both bones that the origins of the *flexor tibialis*, as well as of the *tibialis posticus*, may both be superficial from the heads of the tibia and fibula, and their tendons pass down on the surface of the much larger muscle (Plate IV. fig. 5, *f. t., t. p.*); or, more rarely, the muscle may be altogether absent. On the other hand, owing to increased functions, as a supplemental flexor of a large and specialised hallux, as in *Cuscus* and *Belideus*, where the fibular flexor is also largely developed, it may take origin from both bones, but principally from the tibia.

Its variable condition when divorced from connection with the fibular flexor, and from its office as joint flexor of the toes, is strikingly illustrated, even within the limits of a single genus,

<sup>1</sup> The connections of this muscle are so given by Galton (*l.c.*, p. 597), who, however, calls it the *tibialis posticus*, which really appears to be altogether absent in this as in many other species of mammals to be referred to farther on.



as in *Erinaceus*. In *E. Europæus* this muscle sends off both a fibular and a tibial slip (Plate IV. fig. 3). This is probably due to the comparatively large size of the hallux in this species. In all the other species possessing this muscle (of which the anatomy has been examined by the writer), namely, in *E. grayi*, *macracanthus*, *niger*, and *jerdoni*, its tendon goes only to the superficial fascia and integument of the sole of the foot: in *E. albiventris*, *deserti*, *diadematus*, and *pictus* (and probably in *E. micropus* also), in all of which the hallux is very small or wanting, and the plantar callosity small or obsolete, this muscle is absent (Plate V. fig. 6). In other species of Insectivora the arrangement of the tibial flexor is as follows:—All the species of *Soricidæ* and *Talpidæ* examined had this muscle separated in the foot from the fibular flexor, as in the *Erinaceidæ*; in *Sorex* (Plate IV. fig. 4), it arises from the head and internal margin of the upper extremity of the tibia, and the tendon, passing down in the same groove with and superficial to that of the *tibialis posticus*, is inserted into the sesamoid ossicle lying on the tibial side of the ento-cuneiform bone, and through it is connected by a tendon with the tibial side of the base of the first phalanx of the hallux; in *Talpa*, *Condylura*, and *Myogale* the arrangement is similar. On the other hand, *Galeopithecus*, *Tupaia*, *Macroscelides*, *Potamogale*, *Chrysochloris* and *Solenodon* conform to the *Centetes* type. In *Galeopithecus philippinensis* the *flexor tibialis* arises from the tibia as high up as the insertion of the *popliteus*, and forms (in the leg) two tendons, the superficial becomes external, and sends a slip to the other tendon in the foot; both tendons, however, unite before coalescing with the superficial surface of the tendon of the fibular flexor, but the tendon for the hallux is first given off. In *Tupaia ellioti*, as in the species of *Chrysochloris*, a flat sesamoid bone is formed in the tendon of the flexor fibularis, where it glides across the os calcis; the *flexor tibialis* arises from the greater part of the posterior surface of the tibia from its head downwards, forming a tendon nearly as large as that of the flexor fibularis, with which it unites superficially. In *Potamogale velox* the tibial flexor arises from the interosseous membrane and adjoining margin of the tibia, under cover of the large popliteus, and develops a very slender tendon, which, passing down in the same groove with the *tibialis posticus*, is inserted into the

side of the large fibular flexor. The origins and connections of this muscle in the different species of the family *Centetidae* closely agree with those described above in *Centetes ecaudatus*. In *Chrysochloris* the *flexor fibularis* is large, arising from the greater part of the fibula, and forms a strong tendon, which, receiving on its deep surface the tendon of the *flexor tibialis* immediately before crossing the ankle joint, develops a sesamoid bone, where it lies in the groove on the os calcis, and divides into tendons for the five toes. *Flexor tibialis* is well developed, arising from the back and inner side of the upper third of the tibia, internal to the insertion of the short *popliteus*, and forms a strong tendon, which, owing to the position of the origin of the muscle from the very anteriorly placed tibia, in passing down lies close to the united tibia and fibula, and, consequently, in going to join the fibular flexor at the ankle joint, curves outwards in front of the tendon of the more posteriorly placed *tibialis posticus*, and unites with the deep surface of the tendon of the former muscle.

*Tibialis posticus* is much less variable; in all the species of Insectivora, except in those of *Myogale*, where its tendon unites with that of the *flexor tibialis* above the malleolus (Plate IV. fig. 5), it may be described as arising from the heads of the fibula and tibia and adjacent interosseous membrane, being more or less concealed between the fibular or tibial flexor and the *popliteus*, forming a rather slender tendon, which passes down either in the same groove on the internal malleolus with, and under cover of, the tendon of the *flexor tibialis*, or on its tibial side, and is inserted into the scaphoid, or ento-cuneiform, or, rarely, as in *Chrysochloris*, into the base of the first metatarsal bone. Some of its fibres are often more or less connected with those of *popliteus*.

With these preliminary remarks on the modifications of the long flexor muscles of the feet in Insectivora, we proceed to consider their structure and arrangement in other Mammalian orders.

#### MONOTREMATA.

*Flexor fibularis* arises, in *Echidna setosa*, from the head and greater part of the posterior surface of the fibula, forms a strong

tendon, which receives on its outer edge in the foot the fibres of a large *flexor accessorius*, and divides into three tendons only for the three inner toes, the two outer toes being supplied by the *flexor brevis* only (Plate V. fig. 7, *f.f.*).

*Flexor tibialis* arises from the inner side of the head of the fibula, and forms a moderately large tendon, which crosses the back of the internal malleolus over the tendon of the *tibialis posticus*, and is inserted into the unguis phalanx of the hallux by a broad expansion (fig. 7, *f.t.*).

In *Ornithorynchus paradoxus* this muscle, according to Meckel,<sup>1</sup> contains in its tendon a sesamoid bone, and is inserted into the first phalanx of the hallux.

*Tibialis posticus*, more than double the size of the *flexor tibialis*, arises from the head of the fibula under cover of that muscle and from half the shaft of the bone, and, forming a thick tendon, passes across the malleolus under cover of the *flexor tibialis* tendon to its insertion into the scaphoid bone (fig. 7, *t.p.*).

#### MARSUPIALIA.

*Belideus flaviventer*.—*Flexor fibularis* (Plate V. fig. 8, *f.f.*) arises from almost the whole length of the fibula; about the middle of its posterior surface a superficial part (*f.p.*) separates from the mass, and divides on crossing into the foot into three tendons, which form the perforated tendons for the three outer toes; of these the middle is the largest, and the outer and inner, especially the latter for the third toe, very slender; the perforated tendon for the second toe is derived from the calcaneum; the main tendon divides into five for the five digits, the second and third being very slender.

*Flexor tibialis* (fig. 8, *f.t.*) arises by a fibular and tibial head, the former smaller than the latter; these unite in the upper third of the leg, and pass down in a long tendon, which, crossing the malleolus internally, is inserted into the ento-cuneiform bone and into the sesamoid bone lying on its fibular side.

*Tibialis posticus* (fig. 8, *t.p.*) is exceedingly small, arising under cover of the fibular head of the preceding from the head of the fibula; its very slender tendon passes down under cover of that

<sup>1</sup> *Anat. Comp.*, French ed., vi. p. 425.

of the preceding, and is inserted into the capsular ligament of the calcaneo-scaphoid articulation and into the scaphoid bone.

*Acrobates pygmaeus*.—In the Opossum Mouse the *flexor fibularis* is large, arising from the greater part of the fibula, interosseous membrane, and adjoining margin of the tibia, and, passing into the foot, divides into slips for the five toes. *Flexor tibialis* is much larger than the *tibialis posticus*; it arises from the head and upper fourth of the tibia under cover of the edge of the *popliteus*, and, forming a moderately strong tendon, passes down along with that of the *tibialis posticus*, and is inserted into the internal cuneiform bone. *Tibialis posticus* very small, with an exceedingly slender tendon, arises from the upper part of the interosseous membrane, and from the adjacent sides of the heads of the tibia and fibula, and is inserted into the scaphoid bone.

*Phalangista vulpina*.—*Flexor fibularis* arises from almost the whole posterior surface of the fibula, and forms a thick tendon, which divides into slips for the five toes. *Flexor tibialis* is much smaller, arising from the heads of the fibula and tibia, from part of the interosseous membrane, and from the fibular side of the tibia; its tendon passes down in a groove on the inner malleolus, and is inserted into the ento-cuneiform bone and into the sesamoid bone in the tendon of the plantaris, which plays over the scaphoid tubercle. *Tibialis posticus* is small, arising in intimate union with the *fibular flexor* from the head of the fibula, and from the tibial margin of that bone, also from part of the interosseous membrane, and is inserted into the scaphoid bone, its slender tendon passing down under cover of the *flexor tibialis*.

*Phascolarctos cinereus*.—In the Koala the *flexor fibularis* is very large, arising from almost the whole length of the fibula and part of the interosseous membrane, and forming a strong flat tendon, which gives off in the foot five slips for the five toes. Some of the superficial fibres in the leg separate from the general mass as in *Belideus flaviventer*, and divide it into two heads, from each of which a pair of slender tendons pass down into the foot, and form the perforated tendons for the four outer toes. *Flexor tibialis* is much smaller, arising from the head of the fibula, and from part of the interosseous membrane and surface of the *pronator tibiae* (*popliteus*) muscle; its tendon passes down in a

groove on the tibial side of the internal malleolus, and divides after entering the foot into two flattened tendons connected by an aponeurosis, of which the inner is inserted into the entocuneiform bone, the outer into the side of the sesamoid bone at the base of the first metatarsal. *Tibialis posticus* is very small, arising deeply between the preceding muscles from the head of the fibula and adjoining margin of the interosseous membrane, its very slender thread-like tendon passes into the foot in the centre of the space between the tendons of the fibular and tibial flexors, and is inserted into the calcaneo-scapoid ligament.

*Cuscus maculatus*.—The arrangement of the long flexors is very similar to that of *Belideus flaviventer*, the only difference of importance being that the fibular head of the *flexor tibialis* is smaller, and the tendon of the muscle is inserted into the base of the metatarsal bone of the hallux.

*Phascolomys fossor*.—In the Wombat the arrangement of the long flexors are also very similar to that of *B. flaviventer*, the chief differences consisting in the continuation of the superficial slip of the *flexor fibularis* as a muscular body into the foot, where, as the *flexor digitorum brevis*, it gives off the perforated tendons for the three middle toes, none going to the fifth digit. *Flexor tibialis* arises mainly from the heads of the fibula and tibia, being scarcely connected with the shaft of the latter bone, which is occupied by the insertion of the *pronator tibiæ* (*popliteus*) muscle, and is inserted into the metatarsal of the rudimentary hallux. *Tibialis posticus* is quite similar to that of *Cuscus maculatus*.

*Perameles nasuta*.—*Flexor fibularis* is of great size, arising from the greater part of the fibula, interosseous membrane, and tibia below the insertion of the *popliteus*. The fibular and tibial parts are divided by a groove, in which lies the upper half of the extremely slender tendon of the *tibialis posticus*. These parts form strong tendons, which unite into one large tendon above the ankle joint, which, passing into the foot, divides into three parts—two large for the fourth and fifth toes, and a slender one (which again divides into two) for the rudimentary second and third toes; no tendon goes to the rudimentary hallux. *Flexor tibialis* is altogether absent. *Tibialis posticus* is reduced to the smallest possible size; its muscular part (not larger than

a barley-corn) arises, under cover of the *popliteus*, from the tibial side of the head of the fibula, and forms a thread-like tendon, which lies concealed for half its length in the deep furrow between the tibial and fibular heads of the *flexor fibularis*, then emerging abruptly, and running down on the surface of the tendon of the fibular head, it crosses the internal malleolus in a shallow groove, and is inserted into the scaphoid bone.

Many anatomists would, no doubt, consider the tibial part of this muscle (which, as above described, sends down a tendon to join that of the fibular part above the ankle joint), as the *flexor tibialis*, fused in its muscular part with the *flexor fibularis*; but the fact that its tendon, instead of crossing the *tibialis posticus*, is crossed by the tendon of that muscle, and, moreover, instead of entering the foot in a groove on the back of the internal malleolus, as in all other species, enters it in union with the tendon of the *flexor fibularis*, proves that it is really but the tibial head of that muscle, and that the *flexor tibialis* is altogether absent. This will be additionally demonstrated further on to be actually the case.

*Antechinus swainsoni*.—*Flexor fibularis* is large, arising from the greater part of the fibula and part of the interosseous membrane, and forms a thick tendon, which, passing into the foot, divides into four slips for the four outer toes. *Flexor tibialis* is small, arising from the head of the tibia on its fibular side and from part of the shaft of the bone, forms a long tendon, which glides over the back of the internal malleolus, superficial to that of the *tibialis posticus*, and spreads out into an aponeurosis, from which is given off the flexor tendon of the hallux and the perforated tendons for the other toes, being connected by a narrow fascial band with the tibial side of the *flexor fibularis*. *Tibialis posticus* arises under cover of the preceding from the head of the fibula in connection with the *flexor fibularis*, which, further down, separates it from the interosseous membrane, and, forming a long tendon, crosses the back of the internal malleolus under cover of the *tibialis posticus*, and is inserted into the scaphoid bone.

*Dasyurus macrurus*.—*Flexor fibularis* arises from the greater part of the fibula and the interosseous membrane, and forms a very thick tendon, which divides in the foot into four slips for

the four outer toes. *Flexor tibialis* is moderately developed; arising from the fibular side of the upper half of the back of the tibia, and from part of the interosseus membrane, forms a strong tendon which passes down in a groove on the back of the internal malleolus, superficial to the *tibialis posticus*, and, after entering the foot, divides into three slips,—outer, middle, and internal,—the *outer* becomes confluent with the plantar fascia, and unites with the tibial margin of the expanded *plantaris* tendon, being finally inserted into the integument of the sole of the foot along the base of the longitudinal internal callosity; the *middle* forms a long slender tendon inserted into the terminal phalanx of the rudimentary hallux; and the *internal* is inserted into the ento-cuneiform bone, and, joining the inner tendon of the *flexores breves* of the hallux, into the base of the proximal phalanx of that digit.

The middle division, forming the flexor tendon for the hallux, at first sight appears to be connected with the tendon of the *flexor fibularis*; but the connecting band is found on closer examination to proceed from the side of the os calcis across the under surface of the tendon, and seems to be the rudiment of a *flexor accessorius*.

*Thylacinus cynocephalus*.—*Flexor fibularis* is a very large and powerful muscle. It occupies the outermost place of the deep muscles on the back of the leg, and it takes origin from the whole length of the posterior surface of the fibula. The thick rope-like tendon in which it ends enters the sole by passing forwards on the back of the astragalus, and, after being joined by the tendons of the *flexor tibialis*, it splits into four, viz., a tendon for each toe. *Flexor tibialis* springs from the posterior aspects of the shaft of the tibia in its upper two-thirds, and also by a pointed

<sup>1</sup> Strangely mistaken for the *plantaris* by Owen (*Anat. Vertebr. Anim.* iii. pp. 14, 15), who also describes under the name of *flexor digitorum longus* the interosseous *pronator tibie* muscle. The true *plantaris* really arises, as usual, from the back of the external condyle of the femur, passes down under cover of the *gastrocnemius*, and its tendon, gliding over the heel bone, enters the foot, where it spreads out, becoming united with the plantar fascia, and giving off three tendons, which are inserted into the fascia and integument of the three middle toes, while from its deep surface and from the os calcis muscular fibres arise, from which four tendons are given off to form the perforated tendons of the four outer toes.

and separate process from the back of the internal tuberosity of the tibia and the posterior ligament of the knee joint. At the inner ankle it crosses the tendon of the *tibialis posticus* obliquely, and entering the sole ends by joining the large tendon of the *flexor fibularis*. *Tibialis posticus* is small in size, and intermediate in position between the *flexor fibularis* and the *flexor tibialis*. It has apparently no direct bony attachment at its origin, but springs from the fascia which covers the *popliteus*, whilst, externally, it is inseparably connected with the *flexor fibularis*. At the inner ankle its tendon passes under cover of that of the *flexor tibialis*, and proceeds along the inner margin of the foot to be inserted into the internal cuneiform bone, and into the base of the first metatarsal bone.<sup>1</sup>

*Didelphys virginianus*.—*Flexor fibularis* arises from the greater part of the back of the fibula, and forms a strong tendon, which divides into five slips for the five toes. *Flexor tibialis*, small, arises from the fibular side of the upper fifth of the tibia, lying between the *tibialis posticus* and that bone, and forms a slender tendon, which passes down superficial to that of the *tibialis posticus* on the back of the internal malleolus, and, uniting with the tendinous tibial side of the *flexor brevis* of the hallux, is with it inserted into the base of the first phalanx of that digit. Immediately after crossing the ankle joint, part of the *flexor digitorum brevis* arises from the surface of the tendon of this muscle, and, passing outwards, unites with the general mass of the muscle arising from the tendon of the *flexor fibularis*, so that, at first sight, the tendon of the *flexor tibialis* appears to be united with that of the *flexor fibularis*. *Tibialis posticus*, about the size of the preceding muscle, arises from the head of the

<sup>1</sup> Taken from Prof. D. J. Cunningham's excellent description of the anatomy of this species (*Voyage of H.M.S. "Challenger," "Zoology,"* vol. v. p. 42), the names only of the muscles having been altered. Such a remarkable difference in the mode of the attachment of the tendon of the *flexor tibialis* in two so comparatively closely allied species as *Dasyurus macrurus* and *Thylacinus cynocephalus*, has no known parallel elsewhere, as will be shown when concluding this paper, and suggests the question whether the union may not be due to the remnant of a rudimentary *flexor accessorius*, such as I have described in *Dasyurus*, having formed a connecting band between the tendons, which, originally separate in an ancestral form provided with a hallux, have, with the disappearance of that digit, become thus reunited.



fibula in close connection with the *flexor fibularis*, and forms a slender tendon, which passes down under cover of that of the *flexor tibialis* across the malleolus, but in a separate synovia sheath, and is inserted into the scaphoid bone.

In the poephagous marsupials, *Macropodidæ*, the *flexor tibialis* and *tibialis posticus* become rudimentary, or are altogether wanting. In *Macropus giganteus* the *tibialis posticus* has disappeared, and the rudimentary *flexor tibialis* arising superficially from the inner side of the head of the fibula has its very slender tendon inserted into the ento-cuneiform bone<sup>1</sup>; while in *Hypsi-prymnus gaimardi* (Plate V. fig. 9) the reduction in the number of the flexor muscles of the feet has reached its greatest extent, the *flexor fibularis* alone remaining of the three long flexors, and the short plantar muscles are altogether absent.

#### EDENTATA.

*Tamandua tetradactyla*.—*Flexor fibularis* is very large, arising from nearly the whole fibula, and forms a broad flat tendon, which in the foot receives obliquely on its plantar and inner surface the large *flexor accessorius*.

*Flexor tibialis* appears to be the direct continuation of the lower margin of the *popliteus* into the foot; its slender tendon passes downwards on the inner side of the internal malleolus in a groove by itself, and is inserted into the sesamoid bone over the ento-cuneiform bone.

*Tibialis posticus* is a small muscle arising from the heads of the tibia and fibula and intervening interosseous membrane; its tendon, which is slightly larger than that of the preceding, passes across the malleolus in a groove between those for the preceding muscles, and is inserted into the scaphoid bone.

*Cyclothurus didactylus*.—In the two-toed sloth, according to Galton,<sup>2</sup> a similar arrangement of the *flexor tibialis* (*tibialis posticus secundus*, Galton) and *tibialis posticus* exists.

*Dasyppus sexcinctus*.—The myology of this species has been

<sup>1</sup> It is, of course, impossible to be absolutely sure that this muscle is not the homologue of the *tibialis posticus*, but its superficial position and mode of insertion lead me to consider it the *flexor digitorum tibialis*.

<sup>2</sup> On the Myology of *Cyclothurus didactylus*," *Ann. Mag. Nat. Hist.*, 1869.

described by Owen and Galton, and the following account of the arrangements of the long flexors has been taken from the description of these muscles by the latter writer, the names of *flexor fibularis* and *flexor tibialis* being substituted for those of *flexor longus digitorum* and *tibialis posticus* (in part) respectively.

*Flexor fibularis* arises from the whole posterior surface of the fibula, the interosseous membrane and the fibular aspect of the tibia, forms a broad tendon, which divides into five tendons for the five toes. *Flexor tibialis* arises from the middle third of the posterior surface of the tibia, immediately below the inner head of the *tibialis posticus*, with the tendon of which its tendon passes down, lying in the same groove, but to the tibial side and running over the scaphoid tubercle, is inserted into the posterior part of an ossicle which lies alongside the free edge of the ento-cuneiform bone. From the anterior margin of this ossicle a strong ligament or tendon passes, to be inserted into the tibial side of the base of the proximal phalanx of the hallux. *Tibialis posticus* arises by two short heads, the inner from the upper third of the posterior surface of the tibia, the outer from that part of the head of the fibula which is ankylosed to the tibia.

*Tolypeutes conurus*.—*Flexor fibularis* arises from the posterior surface of the fibula, the whole of the interosseous membrane, and about the middle fourth of the shaft of the tibia, and forms a strong tendon, which, passing into the sole, is there transformed into a thick solid sesamoid ossicle, from the distal end of which the five tendons for the five toes arise. *Flexor tibialis* is very small; it arises as a slight muscular slip from the inner malleolus, and is inserted into the extra free portion of bone at the proximal end of the hallux. *Tibialis posticus* has origin by a somewhat laterally compressed aponeurotic tendon from the head of the fibula, and by fleshy fibres from the back of the shaft of the tibia to the inner side and below the *popliteus*, as far as the upper end of the lower fourth of the shaft. Its tendon glides in a separate groove behind the inner malleolus, passes beneath the internal lateral ligament, and is inserted into the cuneiform bone.<sup>1</sup>

<sup>1</sup> Slightly abridged, and with the names of the muscles changed, from Dr. Murie's paper on the "Three-banded Armadillo," *Trans. Linn. Soc.*, xxx. pp. 101, 102.

*Chlamydophorus truncatus*.—*Flexor fibularis* arises and is inserted as in the preceding species. *Flexor tibialis* arises from the tibia below the insertion of the *popliteus* muscle; its tendon accompanies that of the *tibialis posticus*, and is inserted into the ossicle lying at the proximal end of the halluceal metatarsal. *Tibialis posticus* arises from the head of the fibula, in intimate union with the *flexor fibularis*; its tendon passes round the internal malleolus, and is inserted into the tubercle of the scaphoid bone.

*Orycteropus capensis*.—*Flexor fibularis* arises from the posterior surface of the fibula, from the interosseous membrane, and from the adjoining margin of the tibia, and, forming a strong flat tendon, divides into five for the five toes. *Flexor tibialis* arises in intimate union with both the *flexor fibularis* and the *tibialis posticus* from the inner aspect of the head of the fibula, the opposite-looking edge of the posterior portion of the tibia, and in part from the interosseous membrane. A little above the internal malleolus its tendon is given off, which, passing in a groove superficial to that of the *tibialis posticus*, enters the foot and divides into two slips. One joins by a broad expansion the tendon of the *flexor fibularis*, the other terminates at the posterior part of the sesamoid ossicle, which lies alongside of the ento-cuneiform bone, and which is attached by a ligament proceeding from its anterior extremity to the inner side of the base of the proximal phalanx of the hallux.<sup>1</sup>

The mode of insertion of the tendon of the *flexor tibialis*, as may be seen from the above account, differs from that of other edentates, resembling that of the Insectivore, *Solenodon cubanus* (Plate IV. fig. 2, *f. t.*). In this order, therefore, as in Insectivora, the two leading modifications of the muscle are exemplified. This adds yet another proof to the many of the correctness of Professor Flower's statement that "*Orycteropus* is a form in most respects perfectly apart from all the others."<sup>2</sup>

<sup>1</sup> Slightly abridged, and with the names of the muscles changed, from Galton's paper on the "Myology of the Upper and Lower Extremities of *Orycteropus capensis*," *Trans. Linn. Soc.* xxvi., pp. 596, 597.

<sup>2</sup> *Proc. Zool. Soc.*, 1882, p. 364.

## RODENTIA.

*Lepus cuniculus*.—*Flexor fibularis* arises from the outer surface and back of the rudimentary fibula, from the intermuscular septum separating it from the peronei muscles, from the fibular side of the head of the tibia, and from the interosseous membrane, a few fibres are attached to the fibular margin of the tibia; the muscular mass thus formed sends off two tendons—one flat and superficial, the other (the main tendon) deep and round. These tendons pass round the malleolus together. In the foot the superficial flat tendon joins the tibial side of the larger tendon (Plate VI. fig. 10), and the united tendons send off slips to the four toes, piercing the tendons of the *plantaris*. The smaller superficial muscle is evidently the rudiment of the *flexor tibialis*; the larger, the *flexor fibularis*. There is no *tibialis posticus*; a muscle which has been considered as representing it arises from the prominent postero-internal side of the head of the tibia immediately below the insertion of the tendon of the *semi-tendinosus*, forms a small muscular mass lying on the insertion of the *popliteus*, and a long tendon which passes behind the internal malleolus, and unites at the base of the first phalanx of the inner toe with the tendon of the *extensor communis digitorum* for that toe. This muscle is, however, evidently the representative of the *extensor hallucis longus*, which, in many animals possessing a hallux, sends also a slip to the *extensor communis*.

*Hystrix cristata*.—*Flexor fibularis* arises from the whole length of the fibula and from the interosseous ligament, and, forming a flattened tendon at the ankle, passes into the foot, and receives on its tibial side the smaller and similarly flattened tendon of the *flexor tibialis* (Plate VI. fig. 9), which arises from the tibia, and is connected above with the *popliteus*. *Tibialis posticus* is simple, arising from the heads of the fibula and tibia, and inserted into the scaphoid bone, its tendon passing round the malleolus with that of the *flexor digitorum*.

*Erithizon dorsatus*.—*Flexor fibularis* arises from three-fourths of the posterior surface of the fibula, and, forming a very thick tendon, passes into the foot, where it unites with that of the *flexor tibialis*; the latter arises from the tibia below the insertion of the *popliteus*, and passes round the internal malleolus in a

groove, at the bottom of which lies the tendon of the *tibialis posticus*, which is about the same size, and arises from the head of the fibula and from the adjoining interosseous membrane, and is inserted into the scaphoid bone.

*Syntheres prehensilis*.—*Flexor fibularis* is very strong, arising from almost the whole length of the tibia. *Flexor tibialis* is smaller, taking origin from half the shaft of the tibia posteriorly below the insertion of the popliteus, with which and with the *tibialis posticus* it is intimately connected; its tendon winds round the internal malleolus in a deep groove, at the bottom of which lies the tendon of the *tibialis posticus*, and, spreading out, unites with the superficial surface of the *flexor fibularis* tendon (which divides into three slips for the three inner toes), and sends a tendon to the outermost digit. *Tibialis posticus* is very large—larger than the *flexor tibialis*—arising partly under cover of it from the interosseous membrane, the adjoining edge of the tibia, and from the head of the fibula in connection with the *flexor fibularis*; its tendon, which equals that of the *flexor tibialis*, passes down with and under cover of it in the same groove on the postero-internal side of the malleolus, and is inserted into the scaphoid bone.

*Otodon cumingi*.—*Flexor fibularis* and *flexor tibialis* are both well developed; the former is the larger, arising from the fibula, the fibular margin of the tibia, and the intervening interosseous membrane. *Flexor tibialis* arises from the middle third of the posterior surface of the shaft of the tibia under the insertion of the *popliteus*, and forms a tendon nearly as thick as that of the *flexor fibularis*, which, passing into the foot, unites with the superficial surface of the tendon of the latter muscle (Plate VI. fig. 8). *Tibialis posticus* is quite concealed by these large muscles; it arises from the interosseous membrane and sides of the upper third of the posterior surface of the tibia and fibula, in close connection with both the tibial and fibular flexors, and forms a slender tendon, which, passing round the internal malleolus under cover of the *flexor tibialis*, is inserted into the scaphoid bone.

*Cavia flavidens*.—*Flexor fibularis* arises from almost the whole length of the fibula from the interosseous ligament, and by a few fibres from the tibia, where it is closely connected with those of

the *flexor tibialis*, and, forming a strong tendon, enters the foot, and divides into three tendons for the three toes. *Flexor tibialis* arises from the tibia below the insertion of the *popliteus*, covering and concealing the *tibialis posticus*, and forms a tendon smaller than that of the *flexor fibularis*, which it joins superficially about the middle of the sole of the foot by a flat slip; but the main tendon accompanies the inner tendon of the *flexor fibularis*, and, passing with it through the tendon of the *plantaris* (which forms the perforated tendons for the toes, as in most mammals), is inserted alongside it into the extremity of the last phalanx of the inner toe.

*Cavia cobaya*.—The arrangement of the flexor muscles and their tendons is very similar to that of *Cavia flavidens*.

*Cavia rupestris*.—*Flexor fibularis* and *flexor tibialis* arise together from the fibula, interosseous membrane, and margin of the tibia below the *popliteus*. In the lower third of the leg the slender tendon of the latter separates, and, passing across the internal malleolus with the tendon of the *tibialis posticus* (which lies on its tibial margin), enters the foot and joins the side of the large fibular flexor tendon of the toes, passing chiefly to the inner toe. *Tibialis posticus* arises by a narrow origin from the adjacent parts of the heads of the tibia and fibula, forms a moderate-sized muscle, with a larger tendon than that of the *flexor tibialis*, and is inserted into the scaphoid bone.

*Dasyprocta cristata*.—*Flexor tibialis* is comparatively small, arising from a few delicate fibres from the head of the fibula, but mainly from the back of the tibia, except the part covered by the *popliteus*. It becomes tendinous superficially above the middle of the leg, and joins in the foot the broader tendon of the *flexor fibularis*.

*Chinchilla lanigera*.—*Flexor fibularis* is large, arising from the fibula and interosseous membrane, as well as from the fascia attached to the tibia, and overlying the *flexor tibialis*; its tendon is joined in the foot (precisely as in *Potamogale velox*) by the slender tendon of the *flexor tibialis*, which arises from the upper third of the tibia under the insertion of the *popliteus*. *Tibialis posticus* has a thicker tendon, which runs alongside that of the *flexor digitorum* to the ankle, which it crosses in the same groove, but in a different synovial compartment; it arises from

the heads of the tibia and fibula, but chiefly from the latter, and is inserted into the scaphoid bone.

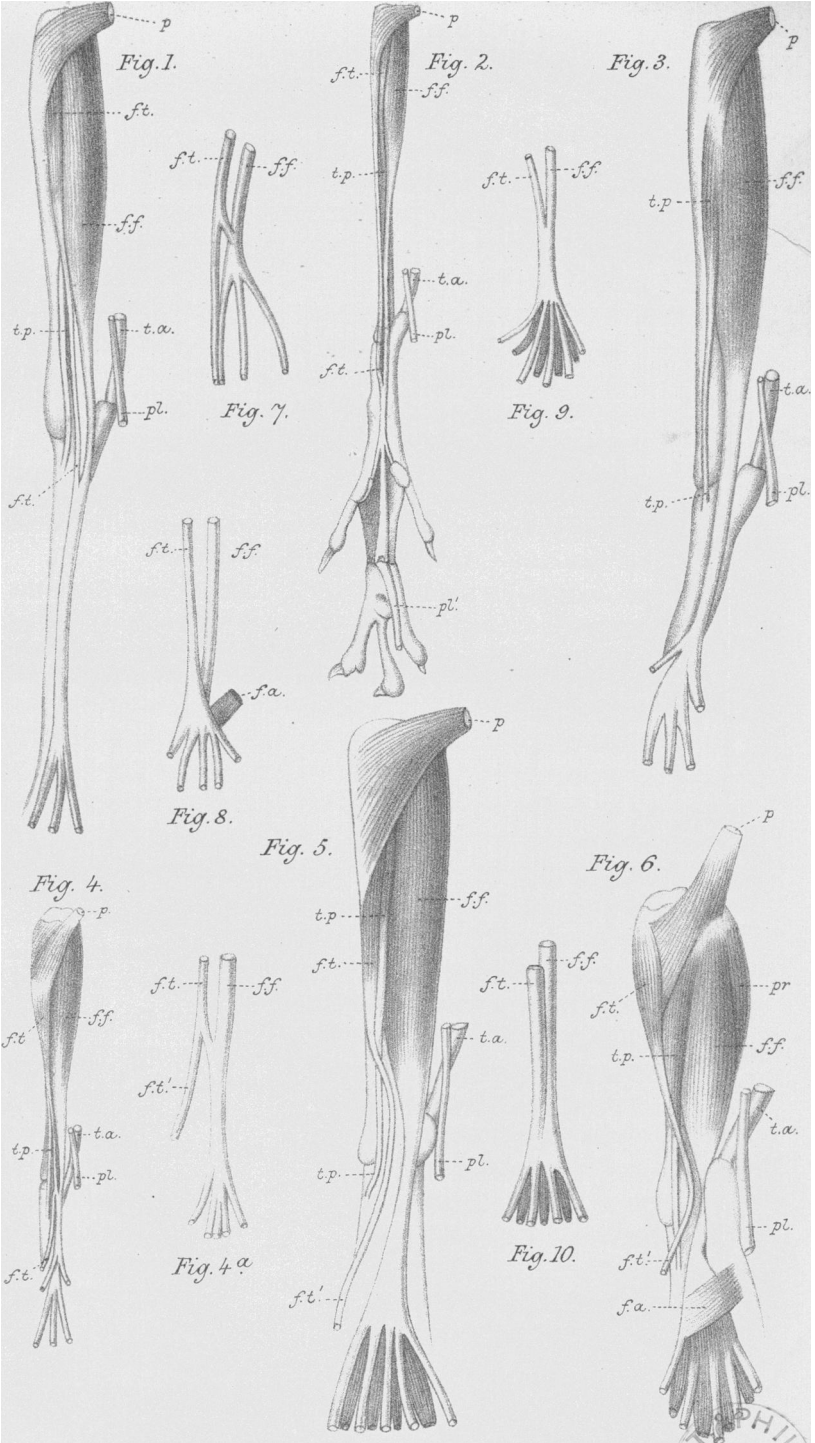
It is remarkable that the relations of these muscles are almost precisely similar to those of the corresponding muscles in the widely-removed *Potamogale velox*.

*Dipus cegyptius*.—The long flexor muscles are almost precisely as in *Chinchilla lanigera*; the *tibialis posticus*, however, differs in being much smaller and wholly concealed above by the *flexor tibialis*, and in having a more slender tendon (Plate VI. fig. 1). The *plantaris* forms altogether the perforated tendons for the three toes, which are but loosely connected with the bases of the first phalanges, and inserted into the sides of the distal extremities of the second phalanges. There is no trace of a *flexor digitorum brevis*, *flexor accessorius*, *lumbricales*, or *flexores breves*.

*Alectaga indica*.—In this five-toed species of *Dipodidae*, the arrangement of the long flexors in the leg is precisely similar to that of the three-toed *Dipus*. The three tendons pass downwards on the back of the tibia, touching by their contiguous margins, that of the *flexor tibialis* being between the other two. Near the ankle the tendons of the *flexor tibialis* and *tibialis posticus* are drawn slightly towards the inner malleolus, which they cross, as usual, in a groove distinct from that occupied by the *flexor fibularis*, with the tendon of which that of the *flexor tibialis* soon unites after entering the foot. The common tendon sends off slips to the first and fifth toes, and much lower down divides into three for the three middle toes. The *plantaris* supplies the perforated tendons for these toes (Plate VI. fig. 2).

*Zapus hudsonius*.—This species,<sup>1</sup> which of all the *Dipodidae* approaches the murine rodents most closely in general structure, has nevertheless also the characteristic hystricine arrangement of the flexor tendons described above. *Flexor fibularis* (Plate VI. fig. 4, *f. f.*) arises from the whole posterior surface of the rudimentary fibula, from the interosseous membrane, and from the fibular margin of the tibia under cover of the *popliteus*, and forms a strong tendon, which passes into the foot and receives on its inner side the tendon of the tibial flexor. *Flexor tibialis* (Plate VI. fig. 4, *f. t.*) is very much smaller, arising from the tibia imme-

<sup>1</sup> The type, according to Coues, of a distinct family *Zapodidae*.





diately below the insertion of the *popliteus*, soon forms a slender tendon, which passes downwards between those of the *flexor fibularis* and *tibialis posticus*, and after crossing the ankle-joint divides (as in *Solenodon cubanus*) into two (fig. 4, *a*), one unites with the tendon of the *flexor fibularis*, to form the perforating tendons for the five toes, the other goes to the base of the central callosity of the sole of the foot. *Tibialis posticus* (Plate VI. fig. 4, *t. p.*) is still smaller, arising under cover of the *popliteus* from the contiguous parts of the heads of the fibula and tibia, and from the interosseous membrane; it passes down under cover of the *flexor tibialis* to the middle of the leg, where its tendon becomes superficial, lying on the tibial side of the tendon of the *flexor tibialis*, and crossing the ankle-joint, is inserted into the scaphoid bone.

*Thomomys talpoides*.—*Flexor tibialis* arises from the tibia immediately below, and almost in continuation of, the insertion of the *popliteus*, crosses the internal malleolus in a groove internal to the *tibialis posticus*, and divides into two tendons; one goes to the sesamoid ossicle over the ento-cuneiform bone, the other is inserted into the side of the *flexor fibularis*. The latter muscle is very large, arising from the fibula and part of the tibia, and receives on its plantar surface the fibres of a large *flexor accessorius*. *Tibialis posticus* is well developed, arising between the preceding muscles from the adjacent parts of the heads of the fibula and tibia, and from the interosseous membrane between, and its tendon, passing down between those of the preceding muscles, is inserted into the scaphoid bone.

*Dipodomys phillipsi*.—The arrangement of the long flexor muscles and their tendons is as in *Dipus aegyptius* (*vide supra*), but the *tibialis posticus* is exceedingly slender, forming an almost invisible tendon.

*Bothyergus maritimus*.—In the great rodent moles of the family *Spalacidae*, on the other hand, we find an arrangement of the long flexors according to the second or *Erinaceus* type. *Flexor fibularis* (Plate VI. fig. 6, *f. f.*) is very large, arising from the whole fibula, part of the interosseous membrane, and the lower half of the tibia, and forms a strong tendon from which the five tendons for the toes are given off. *Flexor tibialis* (Plate VI. fig. 6, *f. t.*) is much

smaller, but well developed, arising from the inner side of the head of the tibia, and passing down across the insertion of the *popliteus* muscle, forms a slender tendon, which crosses the back of the malleolus, and enters the foot internal to the *tibialis posticus*, then crossing obliquely towards the internal cuneiform bone, is inserted into a broad sesamoid ossicle lying on the tibial margin of that bone, corresponding to the plantar callosity at the base of the hallux. *Tibialis posticus* (Plate VI. fig. 6, *t. p.*) is remarkably large, arising from the head of the fibula, in close connection with the *flexor fibularis*, from the adjacent margin of the tibia, and from the lower margin of the *popliteus*, and passing down in a separate groove on the malleolus, on the tibial side of the tendon of the *tibialis posticus*, is inserted into the scaphoid bone.

The *popliteus* (Plate VI. fig. 6, *p.*) is remarkable for its insertion into the head of the fibula as well as into the tibia, and the *flexor accessorius* (*f. a.*) crosses the tendon of the *flexor fibularis* in the foot, to be inserted into the base of the slip given off to the hallux.

If, with the *Dipodidæ*, we compare the anatomy of the long flexors in *Gerbillinæ*, the species of which resemble those of the former family in their long hind limbs, we find, as follows, a totally distinct arrangement.

*Gerbillus indicus*.—*Flexor fibularis* (Plate VI. fig. 3, *f. f.*) is very large, arising from the head and shaft of the fibula as far as its junction with the tibia; from the interosseous membrane, and the adjoining edge of the tibia; forms a strong tendon which divides into five tendons for the five toes. *Flexor tibialis* is altogether absent. *Tibialis posticus* (Plate VI. fig. 3, *t. p.*) is small, arising in close connection with the *popliteus*, and forming a slender tendon, which is inserted into the scaphoid bone. There is a pair of *flexores breves* for each toe, and an *adductor indicis*, in this respect also differing from *Dipus*, in which there are none; but, as in that genus, there are no *lumbricales* and no *flexor accessorius*.

The *Arvicolinæ*, on the other hand, possess the tibial flexor, but its relations are similar to those of the corresponding muscle in *Erinaceus europæus*; in the Musquash,

*Fiber zibethicus*.—*Flexor fibularis* (Plate VI. fig. 5, *f. f.*) is very

large, arising from the rudimentary fibula and interosseous membrane, and by tendinous slips from the upper half of the tibia; it forms a strong tendon, which divides into five for the five toes, receiving no *flexor accessorius*. *Flexor tibialis* (*f. t.*) is very slender, arising from the tibia as a small muscular mass below the insertion of the *popliteus*, and also from the intermuscular fascia between it and the *tibialis posticus*; it forms a slender tendon which passes down superficial and external to the tendon of the latter muscle in the same groove on the back of the malleolus, and running along the inner margin of the foot beneath the integument and areolar tissue, is inserted into the fascia covering the metatarsal bone and first phalanx of the hallux. *Tibialis posticus* (*t. p.*) arises from the tibia under cover of the *popliteus*, and above the origin of the preceding by a much thicker muscular mass, and, forming a thicker tendon, passes downwards, as above described, and is inserted into the scaphoid bone. The *plantaris* divides into four tendons for the four outer toes, those for the third and fourth divide into two slips, each of which pass forward, as usual, on either side of the perforating tendon to their insertions, while those from the second and fifth toes form only a single slip each, which, in the second digit, passes down to its insertion into the *inner* side of the middle phalanx, and in the fifth digit is inserted into the *outer* side of the corresponding phalanx. These tendons, therefore, act not only as flexors, but also as adductors of the second and fifth toes, drawing them outwards from the middle line, and so exposing the fringes of hairs (which in this species take the place of interdigital membranes), as when the animal is swimming, the hallux being abducted by the tendon of the *flexor tibialis*.

*Arvicola amphibius*.—*Flexor fibularis* as above. *Flexor tibialis* arises in close connection with the *tibialis posticus*, and appears to be a direct continuation of the *popliteus*; it forms a slender tendon, which passes down in company with that of the *tibialis posticus*, and superficial to it in the groove on the back of the internal malleolus, and, running along the internal margin of the foot, unites with the tendinous extremity of the inner division of the pair of flexores breves for the hallux, and is with it inserted into the base of the first phalanx; *tibialis posticus* arises under cover of the preceding from the tibia, and forms a slender tendon,

which, passing down as above described, is inserted into the scaphoid bone.

In *Murinae* the arrangement is generally similar to that above described; in *Sigmodon hispidus* the *flexor fibularis* is very large arising from the whole length of the rudimentary fibula, from the interosseous membrane, and from the adjoining tibial margin; *flexor tibialis* arises superficially from the head of the tibia and from the intermuscular fascia, and, forming a very slender tendon, is inserted into the tibial side of the first metatarsal. *Tibialis posticus*, from the heads of the tibia and fibula, under cover of the preceding, forms a thicker tendon inserted into the scaphoid bone.

The *Myoxidae* closely resemble the *Muridae* in the arrangement of the long flexors:—in

*Myoxus avellanarius*, the *flexor fibularis* is as in *Arvicola amphibius*; *flexor tibialis* is, however, much smaller; its very slender, thread-like tendon, after entering the foot, spreads out into a fascial aponeurosis, which is connected with the base of the central callosity of the sole, and with the sheath of the halluceal tendon from the *flexor fibularis*.

The *Sciuromorpha* closely resemble the *Myomorpha* in the anatomy of these muscles, as may be seen from the following descriptions:—

*Sciurus vulgaris*.—*Flexor fibularis* is very large, arising from the greater part of the fibula, the interosseous membrane, and by a few fibres, from the margin of the tibia; it forms a thick tendon, which receives in the foot the fibres of the *flexor accessorius*; and divides into five slips for the five toes, the four outer perforating the four tendons of the plantaris for these digits, the outermost of which receives a tendon from the *flexor accessorius*. *Flexor tibialis* arises from the greater part of the posterior margin of the tibia, some of its fibres being united with those of the preceding muscle, and forms a much smaller tendon, which passes in a distinct groove on the tibial side of the malleolus along with the tendon of the *tibialis posticus*, developing lower down a sesamoid bone, which glides over the *scapho-cuneiform* joint, and the tendon, continuing onwards over the *flexores breves* for the hallux, is, with their inner tendon, inserted into the inner side of the base of the first phalanx of that digit, precisely as in

*Sorex* (see Plate IV. fig. 4, *f. t.*). *Tibialis posticus* is a small muscle which arises from the heads of the fibula and tibia, under cover of the *popliteus*, and forms a slender tendon which passes downwards in a groove on the back of the internal malleolus, along with the tendon of the *flexor tibialis*, and is inserted into the scaphoid bone.

*Sciuropterus layardi*.—The arrangement of the flexors is similar to that above described, but there is only a flat ligament in place of the *flexor accessorius*; *flexor tibialis* is a very small muscle, arising high up under the margin of the insertion of the *popliteus*; its tendon runs down along with that of the *tibialis posticus*, which arises as in *Sciurus*, and both are inserted as in the preceding species; but the *flexor tibialis* is not connected by a tendinous slip with the hallux.

#### UNGULATA.

In all Ungulata, however modified the extremities may be, the arrangement of the long flexors conforms to the five-toed *Centetes* and *Solenodon* type. The following is a description of these muscles in the most specialised form, the one-toed horse, *Equus caballus*. *Flexor tibialis* is very small, arising from the postero-external surface of the head of the tibia above, and internal to the origin of the *flexor fibularis*, and between it and the edge of the *popliteus* muscle, (which occupies the whole postero-internal upper third of the tibia by its insertion); the long slender tendon passes down in a groove on the inner side of the inner malleolus, and joins the large tendon of the *flexor fibularis* about the middle of the proximal third of the metatarsal bone. *Tibialis posticus* is altogether absent.

*Tapirus sumatranus*.—*Flexor fibularis* arises from the upper three-fourths of the shaft and head of the fibula and from the interosseous membrane; its muscular belly, however, reaches to the os calcis, and covers the whole of the fibula. It there forms a strong tendon behind the os calcis, which winds round to the inner side and forms the very strong thick flattened tendon of the sole. This is joined by the *flexor tibialis* opposite the proximal end of the metatarsal, and the two unitedly passing forward about two inches, again subdivide into the three very strong thick and

broad perforating tendons of the digits. *Flexor tibialis* arises by flattened tendinous fascia from the (posterior tuberosity) styloid process of the head of the fibula, deeper and within, but in union with the *flexor fibularis*. It forms a moderate-sized belly, which crosses inwards about the middle of the tibia, and ends in a strong narrow round tendon above the malleolus. This glides in the groove behind the tibial malleolus, and crosses again somewhat outwards in a similar shallow groove, joining the broad plantar tendon of the *flexor fibularis* at the proximal end of the metatarsus. *Tibialis posticus* absent.<sup>1</sup>

*Tapirus americanus*.—In a young specimen of this species, the tendons for the three toes were found given off by the *flexor fibularis* before the *flexor tibialis* united with that muscle in the sole; each of these tendons was joined by a corresponding slip from the *flexor tibialis* before passing through the perforated tendon.<sup>2</sup> According to H. N. Turner<sup>3</sup> the *tibialis posticus* is wanting in this species also.

In these four-toed Ruminants, the arrangement of these muscles is on the same plan as in the one-toed horse, the only difference consisting in the number of tendons given off after the union of the tibial and fibular flexors in the foot; in all cases the *tibialis posticus* appears to be absent.

#### HYRACOIDEA.

*Hyrax dorsatus*.—The *flexor fibularis* is very large, arising from the fibula, interosseus membrane, and adjoining surface of the tibia. *Flexor tibialis* is smaller but well developed, from the head of the fibula with the preceding, from the interosseous membrane, and from the middle third of the tibia below, and external to the large *popliteus*; its tendon is inserted into the side of the larger tendon of the *flexor fibularis* in the foot, and sends a special slip with that of the *flexor fibularis* to the second toe. *Tibialis posticus* is altogether absent, as in *Ungulata*.<sup>4</sup>

<sup>1</sup> This account of the origin and connections of the long flexor muscles of the feet in *Tapirus sumatranus* is taken (with some necessary alterations) from Dr. Murie's paper in this *Journal*, vi. p. 165.

<sup>2</sup> Schulze, Siebold and Kolliker, *Zeitschr. Wissensch. Zool.*, 1867, ii. 15, pl. iii.

<sup>3</sup> *Proc. Zool. Soc.*, 1850, p. 106.

<sup>4</sup> The *flexor accessorius* described by Messrs. Mivart and Murie (*Proc. Zool. Soc.*, 1865, p. 350, fig. 13a) as arising from the plantar surface of the deep flexor tendon,

## PROBOSCIDEA.

*Elephas indicus*.—*Flexor tibialis* arises by tendinous and fleshy fibres from the postero-internal surface of the head of the fibula. An additional slip, small and tendinous, proceeds from the tibia, internal to the insertion of the *popliteus*, from the oblique ligament between the tibia and fibula, and from the septum between it and the *tibialis posticus*. The muscle becomes tendinous opposite the tuberosity of the os calcis, and passes into the sole along a groove at the junction of the astragalus with the sustentaculum tali. *Flexor fibularis*, a larger muscle, arises from the posterior and internal surfaces of the fibula, and from the septum between the two muscles. It passes through a distinct sheath. Opposite the ento-cuneiform bone, the *flexor tibialis*, which lies superficial to the other, spreads out, and blends by its deep surface with the tendon of the *flexor fibularis*. The separate flexor tendons are given off after this junction. The small tendon to the first digit, and that to the fifth, are furnished almost entirely by the *flexor tibialis*, while those to the middle digit proceed from the two flexors jointly (?) *Tibialis posticus* is concealed beneath the *flexor tibialis*. It arises from the posterior surface of the tibia, below what answers to the oblique line; from the adjacent surface of the fibula, and largely from the intermuscular septum between this muscle and the *flexor tibialis*. It ends in a tendon which passes through a distinct sheath on the inner malleolus, and is inserted into the upper surface of the bases of the second and third metatarsals, being crossed, immediately above its insertion, by the *tibialis anticus*.<sup>1</sup>

It appears, however, to me doubtful if this be really the homologue of the *tibialis posticus*, and I am inclined to regard it rather as the representative of the *extensor hallucis longus*, the origin of which has migrated, as in *Lepus* (*vide supra*, p. 159), to the posterior aspect of the tibia. The absence of the *tibialis posticus* would add another character uniting this order with the *Hyracoidea* and *Ungulata*.

and inserted into the middle tendon of the *flexor brevis digitorum* in *H. capensis*, does not exist in Natal specimens of this species.

<sup>1</sup> Miall and Greenwood, *Jour. Anat. and Phys.*, xii. pp. 284, 285.

## CARNIVORA.

The arrangement of the long flexors in *Carnivora* may be described as being formed on the *Centetes* type (Plate IV. fig. 1). There is always a pair of long digital flexors, of which the *flexor tibialis* tendon accompanies that of the *tibialis posticus* round the internal malleolus, and is inserted into the side or superficial surface of the *flexor fibularis*. The following are descriptions of the origins, insertions, and relations of these muscles in some of the most representative species.

*Mustela vulgaris*.—*Flexor fibularis* is much larger than the *flexor tibialis*. It arises from the head and part of the shaft of the fibula and (by a large slip underlying the *tibialis posticus*) from the head of the tibia; forms a large tendon which passes into the foot, and receives the tendon of the *flexor tibialis* on its tibial side. *Flexor tibialis* arises from the greater part of the tibia under cover of, and below the insertion of the *popliteus*, with which it is closely connected, and by a slip from the head of the fibula, in connection with the fibres of the *flexor fibularis*; its tendon passes round the internal malleolus along with the tendon of the *tibialis posticus*, and is inserted into the side of the tendon of the *flexor fibularis*, the common tendon dividing into slips for the five toes. *Tibialis posticus* is well developed, arising from the heads of the fibula and tibia under cover of the *popliteus*, forms in the lower third of the leg a tendon slightly larger than those of that *flexor tibialis*, and, passing round the internal malleolus on the tibial side of the tendon of the latter muscle, is inserted into the ento-cuneiform bone. The *pronator tibiæ* is well developed and quite distinct from the *popliteus*; there is a large *flexor accessorius* which sends also a slip to the tendon for the hallux.

*Herpestes nipalensis*.—*Flexor fibularis* has a very extensive origin, from almost the whole length of the fibula, from the interosseus membrane, and from the fibular side of the tibia from about the level of the *popliteus* insertion, to within a short distance from the distal extremity of the bone; forms a thick tendon, which, passing into the foot, receives the *flexor accessorius*, and on its tibial side the tendon of the *flexor tibialis*, and divides into five slips for the five toes. *Flexor tibialis*, much



smaller, arises by a narrow slip from the head of the fibula, and by a rather extensive origin from the tibia, under cover of the insertion of the *popliteus*, and below it to a short distance below the centre of the bone, and, forming a slender tendon, which passes round the internal malleolus, and is inserted into the tibial side of the tendon of the *flexor fibularis*. *Tibialis posticus* is placed between the preceding muscles, arising from the head of the fibula, and by a few fibres from the fibular margin of the upper third of the tibia in connection with the *flexor fibularis*; it forms a slender tendon, which passes down with and on the fibular side of the tendon of the *flexor tibialis*, and is inserted into the ento-cuneiform bone.

*Viverra civetta*.—*Flexor fibularis*, fibular in origin, is quite separate from the *flexor tibialis* in the leg, the latter is tibial in origin, its tendon runs into the sole, and is there joined by that of the *flexor fibularis*, and splits into five tendons for the five toes. *Tibialis posticus* arises from the posterior surfaces of both tibia and fibula, and passes to the scaphoid bone.<sup>1</sup>

*Nasua socialis*.—*Flexor fibularis* as above. *Flexor tibialis* is comparatively large, and arises from the tibia in connection with the insertion of the *popliteus*, the *tibialis posticus* arising under cover of it from the tibia, interosseous membrane, and part of the fibula. Insertions of the three muscles as above described.

*Nandinia binotatus*.—*Flexor tibialis*, in contrast to the usual condition, is slightly longer than the *flexor fibularis*, and arises from the head of the fibula, the interosseous membrane, and the tibia under cover of the *popliteus*, with which it is more or less connected. *Tibialis posticus* is much smaller, and concealed by it, arising from the heads of the fibula and tibia, and the intervening interosseous membrane; its long flat tendon passes through the groove on the inner side of the internal malleolus under cover of the tendon of the *flexor tibialis*. The tendons of the *flexor fibularis* and *flexor tibialis* unite in the foot, and divide into five slips for the five toes; that of the *tibialis posticus* is inserted into the scaphoid bone.

*Hyæna crocuta*.—*Flexor fibularis* arises from the superior extremity and upper half of the shaft of the fibula, from a corresponding extent of tibia, and from the interosseous mem-

<sup>1</sup> Young, *Jour. Anat. and Phys.*, xiv. p. 175.

brane. *Flexor tibialis* is much smaller, and springs from the head of the fibula and intermuscular septa, separating it from neighbouring muscles. The tendons of these muscles, passing through separate sheaths in the annular ligament, unite in the sole of the foot to form a single broad tendon, from which four slips are derived; these, after perforating the superficial flexor tendons, are inserted into the terminal phalanges of the toes. *Tibialis posticus* is small, and arises below the *popliteus* from the middle third of the postero-internal border of the tibia; its tendon is inserted into the scaphoid and ento-cuneiform bones.<sup>1</sup>

*Canis familiaris*.—In the dog the arrangement of the long flexors is very similar to that above described.

#### CHIROPTERA.

The arrangement of the long flexors of the feet in the bats conforms to the *Centetes* type, and resembles generally that characteristic of the insectivorous genus *Tupaia*, especially in the large size of the *flexor tibialis*, which in this order appears to reach its maximum relative development. There is but slight variability throughout the species, as may be seen from the following account of the relations of these parts in species characteristic of the leading divisions of the order.

*Pteropus samoensis*.—*Flexor tibialis* is very large, arising by a thick fleshy mass from the external condyle of the femur and from the posterior surface of the tibia, forming a strong tendon which unites in the foot superficially with the fibular flexor. *Flexor fibularis* smaller, arises from the fibular side of the head of the tibia, and from the greater part of the posterior surface of the fibula, forms a tendon smaller than that of the *flexor tibialis*, which, on entering the foot, divides into two, which again bifurcate, forming four slips, inserted *seriatim* into the tendons given off by the *flexor tibialis* for the four outer toes, the hallux being supplied altogether by the latter muscle. *Tibialis posticus* is remarkably large,<sup>2</sup> arising from the lower half of the tibia, from the interosseus membrane, and from the adjacent margin of the

<sup>1</sup> Watson and Young, *Proc. Zool. Soc.*, 1879, p. 103.

<sup>2</sup> Thus contrasting with that of *Pteropus edwardsii*, in which this muscle is described by Professor Humphry (*J. A. P.*, vol. iii. p. 13) as being small.

tibia, and forms a strong tendon inserted into the middle cuneiform bone.

*Atalpa cinerea*.—*Flexor fibularis* and *fl. tibialis* are about the same size; the former arises by a narrow head from the external condyle of the femur, and lower down where the fibula becomes strong, from the middle and part of the lower third of that bone; the latter muscle arises from the upper half of the fibular side of the back of the tibia, and, forming a longer and somewhat stronger tendon, enters the foot by passing across the internal malleolus, unites with the superficial surface of the tendon of the *flexor fibularis*, and gives off the tendons for the five toes. *Tibialis posticus* is well developed, arising between and under cover of the preceding muscles, from the interosseous membrane and the adjoining margins of the tibia and fibula, and its tendon, passing into the foot between the tendons of the above-described flexors, is inserted into the fibular side of the scaphoid bone.

The bats are thus seen to differ in the relative size, and, generally, in the relations of their long flexor muscles in the leg, from all other mammals. The *flexor fibularis*, instead of much exceeding the *fl. tibialis* in size, is scarcely equal to it, and, moreover, has its origin from the femur as well as from the fibula, except in the species of *Molossinae* (elsewhere termed by me the most quadrupedal of bats), where the fibula is well developed, and in which alone the gastrocnemius is not in an almost rudimentary condition. In this origin of the *fl. fibularis* from the femur, bats resemble birds. *Tibialis posticus*, also, differs in passing across the ankle between the two long flexor tendons, not, as in the great majority of mammals, on the tibial side of, or under cover of, the *fl. tibialis*.

*Molossus obscurus*.—*Flexor fibularis* arises from the greater part of the back of the fibula. *Flexor tibialis* arises from the heads of the tibia and fibula, but chiefly from the latter bone, and by a few fibres from the interosseous ligament, forms a tendon very nearly as large as that of the *flexor fibularis*, which it joins in the foot, and afterwards divides into tendons for the five toes. *Tibialis posticus*, from the interosseous ligament chiefly, is well developed, forming a tendon, but slightly smaller than that of the *flexor tibialis*, and is inserted into the scaphoid bone,

passing across the malleolus on the fibular side of the tendon of the *flexor tibialis*.

This exemplifies the condition of the flexor muscles in a species with well-developed fibulæ and tibiæ. In the next the fibulæ are very slender.

*Noctilio leporinus*.—*Flexor fibularis*, small, arises from the external lateral ligament of the knee joint, and from almost the whole length of the very slender fibula. *Flexor tibialis* is much larger, arising by two well-developed heads,—an external from the outer side of the head of the tibia, and an internal from the tibia below the insertion of the *popliteus*; these unite and continue to take origin from the upper half of the shaft of the tibia, and form a strong tendon, which passes down on the inner side of the malleolus, and joins the superficial surface of the tendon of the *flexor fibularis*, sending a tendon to the hallux, and uniting with the other to form the slips for the four outer toes. *Tibialis posticus* is well developed, arising from the tibia, under cover of the preceding, and from the interosseus membrane; it forms a strong tendon, which passes into the foot in a groove between the two long flexors, and is inserted into the scaphoid bone.

#### PRIMATES.

All the species conform to the *Centetes* type, although there is much variability in the manner in which the tendons for the toes are given off, often exemplified even in different individuals of the same species.

*Lemuridæ*.—*Flexor tibialis* is a very long but rather slender muscle arising from the upper two-thirds of the posterior surface of the tibia below the *popliteus* and from the peroneal side of the head of that bone, its uppermost part ascending between the tibia and the *rotator fibulæ*. It is inserted by a strong tendon which passes on the tibial side of the *flexor fibularis*, where it gives off a delicate tendon, which joins a corresponding and larger one from the *flexor fibularis* (to form the flexor tendon of the hallux), and, afterwards, becomes intimately blended with the main part of the tendon of the last-named muscle, the two giving rise to the four perforating tendons of the four outer digits, but the

*flexor tibialis* forms almost exclusively that of the fifth digit and but a small part of the others. *Flexor fibularis* is considerably larger than the preceding,—arising from the whole posterior surface of the fibula to its summit and from the whole of the interosseus membrane, also from the peroneal side of the tibia towards its distal end. In the sole of the foot it gives off a large tendon to the hallux, and then blends with the tendon of the last-named muscle.<sup>1</sup>

*Simiadae*.—The new world monkeys resemble the lemurs in the distribution of the flexor tendons. *Flexor fibularis* supplies the three middle toes, sending a slip to join the tendon from the *flexor tibialis* for the first digit. This is also the arrangement in some of the old world species, but in *Cercopithecus* and *Cynocephalus*<sup>2</sup> the hallux is supplied by a tendon from the *flexor fibularis*, which curves in a peculiar manner round the slip given off by the tibial flexor for the second toe.

*Anthropidae*.—The arrangement of the long flexor tendons in man is but a modification of that observed in *Simiadae*.

If now we tabulate the results of the above described investigation into the arrangement of the long flexor muscles of the feet in Mammalia, as follows, we shall find that they have an important bearing on the classification of the families :—

A. <i>Flexor digitorum tibialis</i> united in the foot with the <i>Flexor digitorum fibularis</i> .	B. <i>Flexor digitorum tibialis</i> not connected in the foot with the <i>Flexor digitorum fibularis</i> .	
<p>INSECTIVORA. { <i>Chrysochloridæ.</i> <i>Centetidæ.</i> <i>Solenodontidæ.</i> <i>Potamogalidæ.</i> <i>Macroscelidæ.</i> <i>Tupaïidæ.</i> <i>Galeopithecidæ.</i></p> <p>CHIROPTERA.</p> <p>RODENTIA. { HYSTRICOMORPHA. LAGOMORPHA.</p> <p>EDENTATA. { <i>Orycteropodidæ.</i></p> <p>HYRACOIDEA. } <i>No tibialis posticus.</i></p> <p>UNGULATA.</p> <p>PROBOSCIDEA</p> <p>CARNIVORA.</p> <p>PRIMATES.</p>	<p>INSECTIVORA. { <i>Talpidae.</i> <i>Soricidæ.</i> <i>Erinacidae.</i></p> <p>RODENTIA. { SCIURMORPHA. MYOMORPHA.</p> <p>EDENTATA. { Dasypodidæ. Bradypodidæ. Manidæ.</p>	<p>MONOTREMATA.</p> <p>MARSUPIALIA.</p>

<sup>1</sup> Murie and Mivart, *Trans. Zool. Soc.*, 1872, pp. 80, 81.

<sup>2</sup> Schulze, *l.c.*, plate ii. figs. 3, 3a.

It may be observed, firstly, that the characters derived from the two leading modes of arrangement of the long flexor tendons in the foot are applicable in a very wide sense, for, given a certain species, it may be safely assumed (as I have proved from an examination of a very large series of representative species) that every species of the family, if not of the order, to which the species in question may belong will be found on examination to possess either a similar arrangement of the flexor tendons in the feet or some slight modification not affecting the general law. Thus all the families may be found arranged under one or other of the two sections, A or B, above, and, with three exceptions only, all the orders are similarly distributed. It is further noticeable that, with these three exceptions, all the orders of Placental Mammals are referable to section A, while the Implacental Mammals fall under B. Now, as I have already shown (*vide supra*, p. 146), the arrangement of the flexor tendons in the animals included under B is a differentiated state of a primarily united condition of the homologous structures, such as we find in the species which make up the families grouped under A, it follows that the Implacental Mammals, and a few families of three orders of Placental Mammals, also, of comparatively low position, exhibit in this part of their organisation an advance in development. Furthermore, as it is difficult to conceive that in any animals in which a definite separation of the tibial from the fibular flexors had once taken place, as in those included under section B, symmetrical reunion of these tendons could subsequently occur,<sup>1</sup> so we are unable to consider that any species having the arrangement of the flexor tendons which has been described in the species representing the families and orders of that section, can represent in this respect the condition of the corresponding parts in the ancestral forms from which the great majority of Placental Mammals have sprung.

Secondly, it may be noticed that the mode of arrangement of the flexor tendons has a very important bearing in determining the natural position of certain families and groups of families. This is especially exemplified in *Rodentia* where the group *Hystricomorpha* is placed next *Lagomorpha*, and *Sciuromorpha*

<sup>1</sup> Except under the circumstances referred to above in describing these muscles in *Thylacinus* (see footnote to p. 155).

is associated with *Myomorpha*, an arrangement which, originally adopted from a consideration of other characters, has received the approval of most systematic mammologists. The *Dipodidæ*, although hitherto classed with the *Myomorpha* (by some zoologists even placed next to the true mice), must, according to the arrangement of their long flexor tendons (*vide supra*, p. 162), be removed to the group *Hystricomorpha*. That this, notwithstanding the united condition of the tibia and fibula,<sup>1</sup> is, indeed, their true natural position, is furthermore indicated, not only by the great size of the infra-orbital opening in the skull, but also by the form of the zygomatic arch and by the position of the malar (which is almost identical with that of the *Ctenodactylinæ*), as well as by many other important characters. Again, although the species of *Bathyerginæ* possess the so-called hystriicine form of mandible, their position among *Myomorpha* is further strengthened by the characters derived from the arrangement of their long flexor tendons (*vide supra*, p. 163). In *Insectivora* the close affinity of the three families, *Erinaceidæ*, *Soricidæ*, and *Talpidae*, receives additional confirmation, and a single important character, not hitherto known, for separating them in a group by themselves is afforded. Finally, in *Edentata*, we obtain another most important proof of the isolated position of *Orycteropus* (*vide supra*, p. 158), which has been lately ably demonstrated by Professor Flower.<sup>2</sup>

#### EXPLANATION OF PLATES IV. AND V.

##### Order INSECTIVORA.

Fig. 1. CENTETES ECAUDATUS.—Dissection of posterior aspect of right leg and sole of foot (nat. size), showing the following muscles:—*p. popliteus*; *f. f. flexor digitorum fibularis* (= *flexor hallucis longus*); *f. t. flexor digitorum tibialis* (= *flexor digitorum longus*); *t. p. tibialis posticus*; *t. a. tendo achillis*; *pl. plantaris tendon*; *f. a. flexor accessorius*; *a<sup>1</sup>*, *a<sup>2</sup>*, *a<sup>3</sup>*, *adductor hallucis, ad. indicis, ad. minimi digiti*; underlying them the *flexores breves* may be seen; *ab.o.m. ab-*

<sup>1</sup> Far too much importance has been ascribed to the condition of the leg bones in *Rodentia* as a basis for classifying the families. The union of the fibula with the tibia in *Dipodidæ*, as well as in other mammals, is a purely adaptive character, and should not be considered of more importance than, for example, the union of the metatarsas in *Dipus*, which has also evidently been brought about by special adaptation of the hinder extremities for leaping.

<sup>2</sup> *Proc. Zool. Soc.*, 1882.

*ductor ossis metatarsi minimi digiti*; f. b. *flexor digitorum brevis*. The tendons of the long flexors of the toes are divided above the ankle, and their pedal extremities reflected, showing the distribution of the three divisions of the *flexor digitorum fibularis* (*fl. hallucis longus*) to the three middle toes, those of the *flexor digitorum tibialis* (*fl. digitorum longus*) supplying the hallux and fifth toe.

Fig. 2. SOLENODON CUBANUS.—Dissection of posterior aspect of right leg and part of the sole of the foot (nat. size). (Muscles homologous with those in fig. 1 are indicated by similar letters). The tendon of the *flexor digitorum tibialis* is seen dividing below the ankle-joint into two slips, one unites with the side of the tendon of the *fl. digitorum fibularis*, the other goes to the first metatarsal bone.

Fig. 3. ERINACEUS EUROPEUS.—Dissection similar to that in fig. 2 (nat. size). The cut extremity of the tendon of the *flexor digitorum tibialis* is seen, which, divorced from its connection with the *flexor digitorum fibularis*, goes to the central callosity of the sole of the foot, its inner division retaining, as in *Solenodon*, its attachment to the first metatarsal.

Fig. 4. SOREX (CROCIDURA) CÆRULESCENS.—As above (enlarged). The plantar slip from the tendon of the *flexor digitorum tibialis* has disappeared; that for the first metatarsal bone develops a sesamoid bone, where it glides over the ento-cuneiform bone.

Fig. 5. MYOGALE PYRENAICA.—As above (slightly enlarged). *Flexor digitorum fibularis* so much increased in size that it extends upon the usual points of origin of the *fl. digitorum tibialis* and *tibialis posticus*. The latter is greatly reduced in size, and its tendon has become united above the ankle with that of the former, the united tendons sending a slip (f. t') to the sesamoid ossicle supporting the lobular projection on the tibial margin of the foot, and then continuing onwards to its insertion into the tibial side of the first phalanx of the hallux.

Fig. 6. ERINACEUS PICTUS.—As above (enlarged). *Flexor digitorum tibialis* has altogether disappeared; the *flexor digitorum fibularis* alone forms the deep flexor of the toes.

#### Order MONOTREMATA.

Fig. 7. ECHIDNA SETOSA.—As above (reduced). *Flexor digitorum fibularis* forms the deep flexor tendons for the three inner toes; *flexor digitorum tibialis* arising, as in *Centetes*, from the head of the fibula superficial to the *fl. digitorum fibularis*, is inserted into the unguis phalanx of the hallux; *popliteus*, arising above from the external lateral ligament, is seen extending downwards to form the *promotor tibie*.

#### Order MARSUPIALIA.

Fig. 8. BELIDEUS FLAVIVENTER.—As above (reduced). *Flexor digitorum tibialis* is seen arising from both fibula and tibia, and inserted into the sesamoid ossicle lying on the ento-cuneiform bone. *Flexor digitorum fibularis* gives off the perforating tendons for the five toes;



in the leg its superficial part (*f. p.*) forms the perforated tendons for the same digits. *Tibialis posticus*, passing down under cover of the *flexor tibialis*, sends its very slender tendon (here drawn much too thick) to the scaphoid bone.

Fig. 9. *HYPSIPRYMNUS GAIMARDI*.—As above (reduced). *Flexor digitorum fibularis* alone remains, the other two deep flexors having altogether disappeared, as well as the plantar flexor and adductors, illustrating the extreme degree of reduction in the number of these muscles.

## EXPLANATION OF PLATE VI.

### Order RODENTIA.

Fig. 1. *DIPUS ÆGYPTIUS*.—(Muscles, homologous with those referred to above in the corresponding parts of *Centetes ecaudatus*, are indicated by the same letters). Dissection as above (nat. size), showing arrangement and mode of union of the tendons of the *flexor digitorum fibularis* and *flexor digitorum tibialis*, and position and insertion of that of the *tibialis posticus*.

Fig. 2. *ALECTAGA INDICA*.—As above (nat. size), except that the whole foot is shown in outline, with the divided and reflected tendon of the plantaris (*pl.*), which gives off the perforated tendons for the three middle toes.

Fig. 3. *GERBILLUS INDICUS*.—As fig. 1 (nat. size). The *flexor digitorum fibularis* has altogether disappeared.

Fig. 4. *ZAPUS HUDSONIUS*.—As fig. 1 (slightly enlarged). The tendon of the *flexor digitorum tibialis*, before uniting with that of the *flexor digitorum fibularis*, sends a slip (*f. t.*, better shown in fig. 4 *a*, enlarged), to the base of the central callosity of the sole of the foot.

Fig. 5. *FIBER ZIBETHICUS*.—As fig. 1. The tendon of the *flexor digitorum tibialis* has lost its connection with that of the *fl. digitorum fibularis*, but the representative of the plantar slip in *Zapus* (*f. t.*) remains.

Fig. 6. *BATHYERGUS MARITIMUS*.—As above. *Flexor digitorum fibularis* and *tibialis posticus* are so large that the *flexor digitorum tibialis* has changed its origin (as in *Solenodon cubanus* and *Erinaceus europæus*, Plate IV. figs. 2 and 3) to the inner margin of the head of the tibia; in the foot the relations are similar to those in fig. 5.

Fig. 7. *CAVIA FLAVIDEUS*.—Enlarged drawing, showing mode of union of the long flexor tendons in the foot, also the separate tendons given by each of these muscles to the inner toe.

Fig. 8. *OCTODON CUMINGII*.—Enlarged drawing, showing mode of union of the long flexor tendons in the foot, and junction of the *flexor accessorius* (*f. a.*).

Fig. 9. *HYSTRIX CRISTATA*.—Drawing, (reduced), of long flexor tendons, showing their modes of union in the foot, and division into five slips, (with *lunbricales*), for the five toes.

Fig. 10. *LEPUS CUNICULUS*.—As above.