

2. Notes on the Myology of the Limbs of *Moschus moschiferus*. By F. JEFFREY BELL, Exhibitioner of Magdalen College, Oxford. Communicated by Prof. FLOWER, F.R.S., V.P.Z.S.

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By the kindness of Prof. Flower, I have been enabled to dissect the muscles of the fore and hind limbs of *Moschus moschiferus*, an animal which has been lately made the subject of a monograph by Prof. Flower, presented by him to the Society (P. Z. S. March 16th, 1875). The interest of any new facts that can be brought forward concerning this Deer will be evident to all who heard or have read his paper.

In examining the myology of the limbs, I have dissected the corresponding parts in *Cervus virginianus* (kindly sent me by Mr. A. H. Garrod), *Tragul*us, sp. ? (from the store-room of the Royal College of Surgeons of London), and a common Sheep. I have also been able to make comparisons with the myology of the same parts in *Hyomoschus*, thanks to a paper published by M. Chatin in the 'Annales des Sciences Naturelles' *.

Unfortunately, both in the copy of Cuvier's 'Planches de Myologie' which I saw through the kindness of Mr. Garrod, and in that belonging to the Library of the Royal College of Surgeons, there were no plates of the muscles of a sheep, ox, or deer; but a full description of those of the first two can be found in Chauveau's 'Comparative Anatomy of Domesticated Animals,' which is now easily accessible; and for this reason I have thought it unnecessary to describe, at any length, such muscles as offer no important variations from what we find in the Sheep; in the same text-book will also be found all the more common synonyms of the muscles—a most necessary assistance to myologists in the present confused state of nomenclature.

In the hind limb of *Moschus*, as it came into my hands, the femur was removed. The muscles of the humerus are not described in this paper; but the more striking differences are only found in the arrangement of those muscles which send tendons to the digits.

I. Fore limb.

A. Muscles inserted into the metacarpus.

α. Anterior face.

(1) Extensor metacarpi anterior.

(2) „ „ obliquus.

In the arrangement of these muscles there was no important variation from that which obtains in the same parts in the sheep and deer dissected.

* "Observations sur la Myologie de l'*Hyomoschus*," loc. cit. 5^e sér. Zoologie et Paléontologie, tom. xv. (1872).

In *Tragulus* a similar arrangement obtains. In *Hyomoschus*, however, Chatin notes three muscles in this region, which he names *extenseur gros*, *extenseur grêle*, and *adducteur*. The *adducteur* appears to be the same as the oblique extensor, so far as one can judge from Chatin's account; he does not, however, note the oblique direction of its tendons, which seems to be universal among the Ungulata, as it is found in *Equus*, *Ovis*, *Cervus*, and *Sus*.

The anterior extensor arises by two heads barely separable from one another, on the outer face of the distal portion of the humerus; and from Chatin's description and figure I am led to suppose that he has divided this, which is really one muscle, into a portion "*gros*," and a portion "*grêle*."

The tendon is only double at its distal extremity, where it widens, and becomes bifid, to embrace both sides of the tuberosity of the metacarpus.

β. Posterior face.

- | | |
|-----|----------------------------|
| (1) | Flexor metacarpi internus. |
| (2) | „ „ obliquus. |
| (3) | „ „ externus. |

Here, again, there is no important variation; but we may note that the outer branch of the bifid tendon of the external flexor (3) is inserted into the tuberosity on the external side of the metacarpus, which appears as the proximal end of the fifth metacarpal, united to the rest of the bone in this region, and only represented distally by a short, fine needle of bone; a similar insertion of the tendon was seen in *Cervus virginianus*; in the Sheep the ending is more towards the median line of the metacarpus, while in *Tragulus*, *Hyomoschus*, and the Pig this branch is attached to the head of the entire fifth metacarpal.

B. Muscles inserted into the phalanges.

α. Anterior face.

In the arrangement of the tendons of muscles going to the digits, *Moschus* differs not a little from *Cervus virginianus*, or the Pig. In the former, as in the Sheep, we find that there are three muscles having their insertions in the digits, namely:—

- i. Extensor communis, with tendons to the third phalanges of the median digits.
- ii. Extensor digiti interni (tertii).
- iii. „ „ externi (quarti).

Both of these have two branches—one to the second phalanx, and one directed backwards and ending in the plantar cushion—but no tendons going to the lateral digits, although those ending on the plantar surface, as just described, probably represent what remains of them.

C. virginianus, in addition to the muscles common to it and the Sheep, possesses an extensor dig. minimi.

In the Pig the digits are all supplied from the common extensor, by its division into four branches; while the extensor dig. interni, further, is inserted into both the internal digits, and the fifth possesses a proper extensor dig. minimi.

Now in *Moschus* each digit is provided with an extensor; but the so-called *common extensor*, as in *Cervus*, sends out only two branches, and these for the median digits, into whose third phalanges they are inserted. The internal extensor is inserted into the first phalanx of the third digit, on its anterior face, and the third phalanx of the second, on its inner face. The external extensor is inserted into the outer sides of the second phalanx of the fourth, and of the third phalanx of the fifth digit. A small *extensor dig. minimi* is also present, and is inserted into its second phalanx, after crossing the extensor of the fourth digit, in the last or distal third of the metacarpus, as in *C. virginianus*, as already described, though not as in the Sheep, where this muscle is absent.

In *Tragulus* the common extensor is inserted only into the median digits; but in *Hyomoschus*, as Chatin says, the arrangement is Porcine; that is, the common extensor is inserted into all four digits.

As in the Sheep and Pig, the extensors of the phalanges arise on the outer side of the radius, and from the external tuberosity of the humerus; their tendons passing together along a deep groove on the outer face of the distal end of the radius, in a strong fibrous sheath, are directed, according to their destination, more or less inwardly along the anterior face of the metacarpus. Separated from these, however, is the tendon of the internal extensor, the fleshy body of which lies on the flattened outer face of the ulna, while the tendon itself, more deep, has a separate carpal sheath; when it has passed through this, it widens, but does not bifurcate till it approaches the distal end of the metacarpus.

β. Posterior face.

- | | |
|----------------|--------------------------|
| (1) Perforatus | } flexors of the digits. |
| (2) Perforans | |

The short flexor of the fifth digit, which is found in the Pig and *Hyomoschus*, is absent.

In no known Ungulate does the *perforatus* send tendons to the lateral digits, but only to the second phalanx of each median digit. In all members of the group its fleshy portion consists of two masses of muscle, arising beneath the *flexor metacarpi obliquus*, from the internal condyle of the humerus; in the Sheep these two tendons, arising from the two muscular masses, one from each, unite in the metacarpal region, and, more distally, bifurcation occurs; in *Cervus virginianus*, the two tendons remain separate, as also in the Pig and *Hyomoschus*. In *Moschus*, however, there is a certain union of the tendons, by means of a fine slip of tendon running from the inner to the outer branch, in the metacarpal region.

The *perforans*, as in the Horse, Sheep, and Pig, consists of three muscular portions, called by Chauveau epitrochlean, ulnar, and radial,

from each of which a tendon arises; these three tendons unite into one, strong and deeply situated, at the carpus.

In the Sheep and *Cervus*, only two branches are formed by this tendon, one for the third phalanx of each median digit; but in *Moschus*, shortly before reaching the metacarpo-phalangeal region, there is given off from each side a delicate tendon, which is inserted into the third phalanx of the second and fifth digits respectively; while the remainder, scarcely diminished in size, passes through the sheath afforded it by the tendons of the perforatus, shortly after its own bifurcation.

A similar arrangement obtains in *Hyomoschus*, according to Chatin; in the Pig, however, the perforans is divided into four distinct branches. There are no lumbrical or interosseous muscles, as might be inferred from the structure of the bones of the manus. *Hyomoschus* has one lumbrical and four interossei, as the Pig.

II. Hind limb.

The femur, as already stated, was removed, so that it was impossible to note the origins of several muscles, as had been done in the fore limb; but I saw nothing to lead me to suppose that there was any variation from that which ordinarily obtains among Ruminants.

On removing the skin and fascia, it was very easy to separate, on the posterior side of the leg, in the tibial region, a large triangular mass of muscle, terminating in a tendon, which seemed to be inserted into the head of the process of the calcaneum, and then to pass on to the digits. Such an appearance is common enough in the hind limbs of Ungulates, and seems to have given rise to Prof. Owen's remark that the gastrocnemius sends a tendon to the digits*—the fact being, indeed, that the tendon which thus crosses, as described by Owen, over the calcaneum, but which is not inserted into it, is that of the *plantaris* muscle, the arrangement of which was clearly pointed out by Meckel†, in speaking of the Horse:—

“Chez les solipèdes le *plantaire grêle* et le *court fléchisseur commun* sont confondus; ou, si l'on veut, le dernier est avorté. . . . Le tendon du muscle se dirige d'abord au devant de celui du triceps de la jambe [*i. e.* the gastrocnemius and soleus]; arrivé au calcanéum, il se place derrière ce tendon, s'épanouit et s'insère à la grande apophyse de cet os‡; puis il se prolonge en avant.”

By others, again, the soleus has been considered the muscle from which the perforated tendon arises, as Chatin says§:—

“D'après plusieurs auteurs, Stannius entre autres, le soléaire

* “The chief peculiarity of the flexors of the digits of the hind foot in hoofed quadrupeds is the accession of muscles not so applied in other mammals. Thus the ‘gastrocnemius,’ besides its insertion into the heel-bone, sends a strong tendon along the back of the metatarsal, to the phalanges, where it expands and bifurcates, each division again splitting for the passage of that of the ‘flexor perforans’ before being inserted into the middle phalanges.”—*Anat. of Vertebrates*, vol. iii. p. 46.

† *Anat. Comp.* French ed. vol. vi. p. 442.

‡ It would be more correct to say that at this point the tendon is surrounded by a fibrous cap, inserted into the bone, which it has itself formed.

§ *Loc. cit.*

manque rarement chez les Mammifères ; mais en général, au lieu de contribuer à la formation du tendon d'Achille, il se terminerait par un tendon propre, qui chez les Ruminants, le Cochon, et le Chien, se diviserait pour se rendre aux orteils, de sorte que ce muscle jouerait le rôle d'un court fléchisseur des orteils, outre celui qui lui est ordinaire.

“ Dans l'*Hyæmoschus*, cependant, pas plus que dans le *Cervus mexicanus*, une pareille duplicité de fonction ne saurait être attribuée au soléaire, car le fléchisseur des orteils qui glisse sur la face postérieure du calcanéum, comme sur une poulie de renvoi, en est bien distinct. Cuvier n'indique, d'ailleurs, nullement ce mode de terminaison du soléaire se prolongeant jusqu'aux orteils pour en former le fléchisseur superficiel.”

It may, then, I think, be fairly concluded that the tendon which is perforated in the hind limb of Ungulates, is that which arises from the *plantaris* ; and this is the view taken by Prof. Huxley * and by Mr. Mivart †.

A. Muscles inserted into the tarsus.

α. Anterior face. None.

β. Posterior face.

(1) Gastrocnemius.

(2) Soleus.

These two muscles ordinarily unite their tendons before being inserted into the calcaneum, and therefore have been described, chiefly by French anatomists, as in the above quotation from the French edition of Meckel, as one muscle, under the name of the *triceps of the leg*; for the gastrocnemius has two heads. But in *Moschus*, as in *Tragulus*, the tendons of the two muscles are easily separable for their whole extent, but a muscular branch unites their fleshy bodies.

The soleus is present in *Hyomoschus*, but absent in the Pig.

B. Muscles inserted into the metatarsus.

α. Anterior face.

(1) Extensor metatarsi internus.

(2) „ „ anterior *sive* medius.

(3) „ „ externus.

The median and internal flexors pass, with the common extensor of the digits and the extensor of the fourth digit, through a highly fibrous tarsal ring. The flexor internus is larger at its origin than in the Sheep ; but in both animals, as also in *C. virginianus*, it arises both from the head of the tibia and from the strong ridge on the anterior face of the same bone. Chatin makes the vague observation concerning this muscle, that it is “ assez dissemblable chez le *Cervus mexicanus* comparé à l'*Hyæmoschus*.” I observed no variation in its arrangement in *Moschus* from that which obtains in *C. virginianus* ; and the only point in which it differs from the arrangement in the

* Anat. of Vertebrata, p. 56.

† Elementary Anatomy, p. 354.

Pig is, that it terminates on the proximal end of the metatarsal, instead of on the second cuneiform.

The *extensor metatarsi anterior*, and the *extensor digitorum communis* are barely separable in the muscular portions, as in the Sheep, Deer, *Hyomoschus*, and the Pig. The external extensor crosses over the tarsus, in close company with the proper extensors of the fourth and fifth digits; in the Sheep, as might be supposed, and in *C. virginianus*, the proper extensor of the fifth is absent. Save in this particular, there is no variation in the arrangement of this external extensor in Ruminants from that which obtains in the Pig.

β. Posterior face of the metatarsus; no muscles are inserted into it.

C. Muscles of the digits.

α. Anterior face.

- (1) Extensor digiti quinti.
- (2) „ „ quarti.
- (3) „ digitorum communis.
- (4) „ digiti tertii.

(1) The tendon of this muscle is in close proximity to that of the extensor dig. quarti, till it approaches the phalangeal or distal end of the metatarsus, where it widens, separates from it, and is inserted into the third phalanx of the fifth digit. It is absent in *C. virginianus*, as in the Sheep.

(2) This muscle terminates by a broadened strong tendon, on the second phalanx of the fourth digit, as in the Sheep, *Cervus*, *Hyomoschus*, and the Pig.

(3) The *common extensor* has only two branches, which end in the third phalanges of the median digits, as in *Cervus virginianus*; but the same muscle has four branches in *Hyomoschus*, as in the Pig—though only two in *Tragulus*, as in the manus.

(4) In close connexion with the common extensor arises the extensor of the internal digit, which terminates in the second phalanx of the third, and the third phalanx of the second digit. No branch for the second digit was found in *C. virginianus*; but the lateral digits of the pes have no metatarsal bones at all, although there are small metacarpals in the manus.

Chatin notes no internal flexor in *Hyomoschus*, which is strange, as the muscle is found in the Pig and in *Tragulus*, as well as in the Sheep and *Cervus*.

β. Posterior face.

- (1) Perforatus.
- (2) Perforans.
- (3) Flexor obliquus.

The *perforatus* muscle has been already spoken of; it only now remains to be added that it has only two branches, as in the manus.

The *perforans*, again, has but two tendons, and those for the median

digits, whereas, it will be remembered that, in the manus, the lateral digits also received tendons from this muscle; but the lateral toes of *Moschus*, in the pes, are much smaller than those in the manus, and the metatarsals are absent, as has been pointed out by Prof. Flower. In *Hyomoschus*, and the Pig, tendons are sent to all four digits.

The tendon of the oblique flexor, after having passed through the strong fibrous sheath found on the inner side of the tarsus, becomes directly afterwards united with that of the perforans; in the Sheep the union takes place somewhat lower down the metatarsus, in *Cervus* at about the same spot.

D. Muscles of the pes.

The *pedal* is a small muscle, arising from the inner face of the calcaneum, and attached to the tendon of the common extensor; it has no attachment to the inner extensor as in the Sheep and Deer; nor has it two branches for attachment to the two tendons of the common extensor as in *Hyomoschus* and the Pig. There are no *interosseous* muscles, of which there are four in *Hyomoschus* and the Pig.

SUMMARY.

The most interesting points in the foregoing description are those which refer to the arrangement of the tendons inserted into the digits.

i. They are interesting morphologically, as showing what was the arrangement in the common ancestor of the true Cervidæ and of *Moschus*—namely, that the extensor communis digitorum had only *two* tendons, and those for the median digits; for the same character obtains in *Tragulus*; while they offer a further proof of Prof. Flower's positions:—(a) That *Moschus* has close affinities to the true Cervidæ; for this same arrangement seems to be constant throughout the group, although different in *Hyomoschus**. (β) That *Moschus* is an older and more generalized form; inasmuch as it still possesses tendons for the lateral digits, arranged in the same manner as in *Tragulus*.

The absence of flexor tendons, arising from the *perforans*, and inserted into the lateral digits of the pes, may cause further stress to be laid on the small size or complete absence of the metatarsals, which is so highly characteristic of the Cervidæ.

ii. They are interesting physiologically, as showing how the Musk-Deer managed to hold on to the rocks and crags of its home by all four toes, in the manner described in Prof. Flower's paper.

It will not, I trust, be long before we know what arrangement obtains in the Reindeer, in *Hydropotes*, and others. I trust that the evidences adduced on the subject of the homology of the perforated tendon of the pes in the Ungulata, may settle this question, so far, at any rate, as the gastrocnemius is concerned.

* The vagueness of some parts of M. Chatin's description demands a reconsideration of the myology of *Hyomoschus*.



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