

ON THE MORPHOLOGY OF THE TENDO-ACHILLIS.
By F. G. PARSONS.

IN dissecting the muscles of a Canadian beaver some little time ago, I found, as Meckel states, that the two bellies of the gastrocnemius remained separate down to their insertion in the os calcis. I also noticed that the two tendons of the muscle and that of the plantaris were twisted round one another like the strands of a rope, so that the tendon belonging to the internal head passed superficially to that of the external and to the plantaris tendon, and was inserted externally to both of them. Further down, the plantaris became superficial to the external head, and passed in a groove in the back of the tuberosity of the calcaneum to be continued into the plantar fascia and flexor brevis digitorum. This arrangement is shown in the accompanying figure.

I then examined a series of other mammals, including the kangaroo, many rodents, the chevrotain, the dog, the ichneumon,

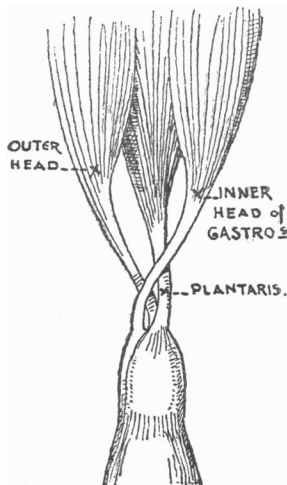


FIG. 1.—Tendo-Achillis of Beaver (*Castor canadensis*).

and the macaque, and found that, although the two tendons of the gastrocnemius were fused, they could, with little difficulty,

be separated, and that when this was done the same arrangement was evident.

In birds, the two tendons unite just before they reach the tarso-metatarsus, but I could not satisfy myself that the same crossing exists.

In lizards, among reptiles, the inner head of the gastrocnemius is quite separate, and crosses over the outer head to reach the external side of the foot.

On carefully examining the tendo-Achillis of the lower mammals it will be noticed that the four parts of which it is composed—the two heads of the gastrocnemius, the soleus and the plantaris—have undergone a twist of half a circle. This I was able to prove by separating the different parts in a puppy, after which I cut through the ankle-joint and turned the foot round until the toes pointed backwards; when this was done, the two tendons of the gastrocnemius and that of the plantaris became untwisted, and lay parallel to one another.

The same twist may be seen in the tendo-Achillis of Man, though it is modified by the great development of the soleus as an adaptation to the erect position. If the human tendo-Achillis be carefully looked at, it will be seen that the fibres from the inner head of the gastrocnemius pass obliquely downwards and outwards over the rest of the tendon, to be inserted on its outer side. This arrangement is figured in many textbooks, notably in Henle, but I have not met with any description of it. That the soleus part of the tendon undergoes the same twisting I was made aware of in dissecting a human foetus of about five months: in it I could distinctly trace the soleus winding round the inner side of the rest of the tendo-Achillis, to be continued into the flexor brevis digitorum in the sole. In a foetus a little older this connection of the soleus was lost; but it is quite easy, in a 7 months human foetus, by a little careful dissection, to separate the part of the tendo-Achillis which is formed by the soleus from that formed by the gastrocnemius; when this is done, it will be seen that just before the insertion into the tuberosity of the calcaneum, the outer part of the tendon is formed by the gastrocnemius, while the inner and large part is continuous with the soleus.

I have had the opportunity of examining foetuses of the horse

and sheep, but did not find that the soleus joined the flexor brevis digitorum, probably owing to the fact that in these animals the soleus is a very rudimentary muscle. On the other hand, the plantaris tendon is continued at quite an early stage

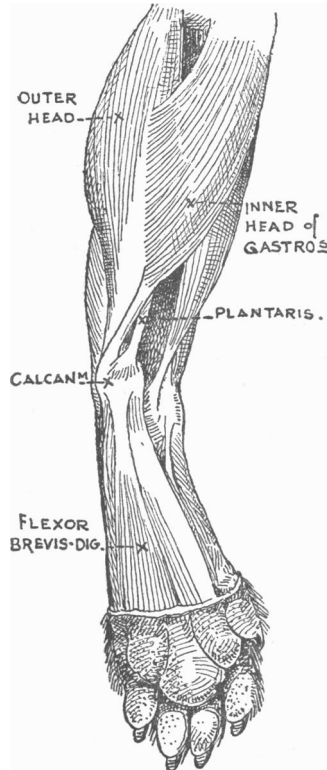


FIG. 2.—Tendo-Achillis of Ruddy Ichnumon (*Herpestes smithi*).

into the flexor brevis, so that in these ungulates the three typical flexors of the phalanges have been converted into two.

This has been done by the suppression of the proximal part of one muscle and of the distal part of another, followed by the junction of the two remaining halves.

In other words, the plantaris, the flexor of the proximal phalanges (corresponding to the flexor perforatus of birds), practically loses its foot portion in the horse and sheep, there being little or no plantar fascia in these animals; while the

flexor of the middle phalanges (corresponding to the flexor perforans et perforatus of birds) retains its foot portion as the flexor brevis, but its leg portion, the soleus, becomes rudimentary. Finally, the plantaris joins the flexor brevis to form one continuous muscle. A stage in this transition can be seen in the beaver, in which, as above mentioned, the plantaris splits into two layers, the superficial being the plantar fascia, and the deep the flexor brevis digitorum.

The rope-like twisting of the four tendons of the gastrocnemii, the soleus, and the plantaris has been described by Dr Murie in the Malayan tapir,¹ but I am not aware that it is known to exist in most mammals, including Man.

Two explanations of this internal twist have occurred to me. The first is the internal rotation which occurs in the foetal limb by which the dorsal surface becomes the anterior: this rotation occurs above the knee-joint, and therefore would be above the present attachments of the muscles entering into the composition of the tendo-Achillis. There is every reason to think, however, that the vertical separation of these muscles took place before they acquired their present attachments near the knee; in other words, that there were muscles stretching from the ischium to the sole which might have shared to a slight extent in the rotation of the limb. But whether this had any influence or not, it certainly could not account for the 90° of twisting which is found in the adult.

The other explanation that suggests itself is the position of the foetal limb in utero: the ankle is dorsally flexed and the foot is adducted, so that in the foetal lamb or horse the two feet are crossed underneath the abdomen. This position of the foot, which is found in a less marked degree in the human foetus, might account for a still further rotation of the tendon. Whatever the cause may be, it does not seem to act only on the constituents of the tendo-Achillis, for in the other tendons which cross one another on the flexor aspect of the leg and foot it is the internal which crosses superficially to the external. Examples of this are the flexor longus digitorum and tibialis posticus, also the flexor longus digitorum and flexor longus hallucis.

¹ *Jour. Anat. and Phys.*, 1872, p. 163.

Respecting the serial homology of the muscles composing the tendo-Achillis, my dissections bear out the theory that the plantaris is homologous with the palmaris longus, and that the soleus and flexor brevis digitorum correspond to the flexor sublimis digitorum. With regard to the theory that the two heads of the gastrocnemius correspond respectively to the flexor carpi radialis and ulnaris, I made two or three dissections in different mammals to find out where the nerve supply came from. As the internal plantar nerve corresponds in its distribution to the median, and the external plantar to the ulnar, I expected that, on separating these two nerves up to the thigh, each of them would give off the branch to one of the heads of the gastrocnemius. As a matter of fact, I was disappointed to find that the two nerves to the gastrocnemius were connected together in the thigh, and could be traced up as a single cord as far as the great sciatic foramen without being bound up in either of the plantar bundles. From former dissections, however, I am inclined to regard this fact as merely pointing to the comparative untrustworthiness of nerve supply in determining the homologies of muscles.