VI. *Account of a Peculiarity in the Distribution of the Arteries sent to the Limbs of slow-moving Animals; together with some other similar Facts.* *In a Letter from Mr.* Anthony Carlisle, *Surgeon, to* John Symmons, *Esq. F. R. S.*

Read Jan. 9, 1800.

DEAR SIR,

THE Maucauco you have been so obliging as to give me for the purpose of dissection, has proved a subject of considerable interest. This animal, the *Lemur tardigradus* of LINNÆUS, was injected, with a view to exhibit the course of the arteries; and they present a very unusual deviation from the ordinary arrangement of this class of blood-vessels in animals generally. Before I had leisure to inquire further into this peculiarity, I presented a drawing of the appearances to my friend Dr. SHAW, of the British Museum, for the purpose of being made public in his work of natural history, now in the press. Since that time, I have, through Dr. SHAW's assistance, been enabled to investigate this subject somewhat farther; and, if you consider the following account in any degree worthy the attention of the Royal Society, I shall receive an additional honour by its proceeding through your hands.

The *Lemur tardigradus*, in its injected state, accompanies this paper; and, for the kind of preparation, the vessels are filled with more than ordinary success. The arteries alone are injected; and the peculiarity of their arrangement is to be observed in the axillary arteries, and in the iliacs. These vessels, at their entrance into the upper and lower limbs, are suddenly divided

into a number of equal-sized cylinders, which occasionally anastomose with each other. They are exclusively distributed on the muscles; whilst the arteries sent to all the parts of the body, excepting the limbs, divide in the usual arborescent form; and, even those arteries of the limbs which are employed upon substances not muscular, branch off like the common blood-vessels. I counted twenty-three of these cylinders, parallel to each other, about the middle of the upper arm; and seventeen in the inguinal fasciculus.*

This fact appeared at first too solitary for the foundation of any physiological reasoning; but, having since had an opportunity of prosecuting the inquiry, among animals of similar habits and character, I have been encouraged to hope that the result may eventually assist in the elucidation of muscular motion. The *Bradypus tridactylus*, or great American Sloth, has a similar distribution of the arteries of its limbs to that already described in the *Lemur tardigradus;* which will be better understood by the annexed figures. See Plate II. figs. 1 and 2; and the explanations. The communications of these vessels with each other are more frequent than in the *Lemur tardigradus*, and their number is considerably greater. I counted forty-two separate cylinders upon the superficies of the brachial fasciculus; and, from the bulk of the fasciculus, I estimate that there were twenty, or more, concealed in the middle. The lower extremity has its arteries less divided, and they are of larger diameter. I observed only thirty-four branches in the middle of the thigh; and the first series of ramifications were larger than the subsequent ones. May not this have some relation to the greater distance of the lower limb from the

* See Plate I. and its references, page 103.

heart? The extremely slow movements of the *Bradypus tridactylus* are sufficiently known among natural historians.

The *Bradypus didactylus* has its arterial system distributed in some degree like the *tridactylus;* but the brachial artery in the upper limb is much less subdivided, as will appear by the representation in Plate II. fig. 3; and, in the lower limb, the arteries of the plexus afterwards divide a few times in the arborescent form. It may be worthy of remark, that this correspondence of arrangement, in the arteries of the lesser Sloth, bears a striking analogy with the structure and habits of the large American Sloth; the movements of the *Bradypus didactylus* being universally represented quicker than those of the *Bradypus tridactylus.*

The *Lemur Loris* was next examined, and its arterial system was found to resemble those already described; but, as the animal had been preserved in very strong spirit, the vessels were so corrugated as not to admit of injection. The two *Bradypi* were injected with quicksilver. The natural history of the *Lemur Loris* appears not to be very well ascertained; but it is a slow-moving animal, and has been confounded with the species called *tardigradus*, although doubtless a much more agile creature. See Plate II. figs. 5, and 6.

In all the quadrupeds before mentioned, the other blood-vessels, as well as the nerves, presented the common appearances. The size of the heads, and the interior capacity of the skulls, both in the *Bradypus tridactylus* and the *Lemur tardigradus*, seemed smaller in proportion than is usual among animals, so that the quantity of brain must be less than ordinary.

The effect of this peculiar disposition of the arteries, in the limbs of these slow-moving quadrupeds, will be that of retarding the velocity of the blood. It is well known, and has been

explained by various writers, that the blood moves quicker in the arteries near the heart, than in the remote branches; and also, that fluids move more rapidly through tubes which branch off suddenly from large trunks, than if they had been propelled for a considerable distance through small-sized cylinders; besides which, the frequent communications in the cylinders of the *Bradypus tridactylus* must produce eddies, which will retard the progress of the fluid. From these and a variety of other facts, which it is not necessary to specify, it will appear, that one effect upon the animal economy, connected with this arrangement of vessels, must be, that of diminishing the velocity of the blood passing into the muscles of the limbs. It may be difficult to determine, whether the slow movement of the blood sent to these muscles be a subordinate convenience to other primary causes of their slow contraction, or whether it be of itself the immediate and principal cause. The facts at present ascertained, relative to muscular motion, do not authorize me to treat decidedly of the share which the vascular system holds in the operation of muscular contraction. Certain it is, that a larger proportion of arteries is sent to the muscles of quadrupeds, than to the ordinary substances; and the extreme redness of these organs shews that their capillaries are of large diameter. A greater degree of redness is also observable in those muscles (of the same animal) which are most frequently called into action. The habits of life among the tardigrade animals, give occasion for the long continued contraction of some muscles in their limbs: these creatures are represented clinging to the boughs of trees, and remaining thus, without locomotion, for several hours. The powers which require so long a time to determine the contraction of a series of muscles, are probably

no less slow in restoring the parts to their former condition; or, if the restoration is to be effected by antagonist muscles under the same circumstances, then, the flexion and extension of every part of the limbs will correspond, as to time.

I have not met with any arrangement of blood-vessels analogous to those described, except in the carotid artery of the Lion. May not this peculiarity be subservient to the long continued exertion of the muscles of his jaws, whilst holding a powerful animal, such as a Horse or Buffalo, and thus enable him to retain his prey, until it is wearied out by ineffectual struggles? I believe also, that those animals which chew the cud, have a plexus of arteries in the neck, analogous to the *rete mirabile:* but this fact has not yet been verified in all the ruminating quadrupeds; and the effect of these arrangements seems rather to operate as sluices to the arteries of the masticating muscles, than directly as the means of retarding the velocity of their fluids. It is however necessary to examine these subjects more accurately.*

As I have instituted a series of experiments and inquiries, with the hope of elucidating this subject, it would be improper to trouble you, or the Royal Society, with any physiological reasonings until these are completed.

I have the honour to be, &c.

ANT. CARLISLE.

Soho Square,
October 28th, 1799.

* There is a *rete mirabile* in the genus *Bos*, and in some of the *Cervi* which I have seen; but of these and the other *Pecora* a fuller description will be given in a future paper.

P. S. The Maucauco which you lately possessed, was sufficiently quick in the movements of its head to snap a person's finger, when touched incautiously; and the motion of its jaw, when chewing, was not slower than in other animals. A Maucauco of the same species, kept among the wild beasts in the Tower of London, was very apt to bite those who, calculating the movements of its head by those of its limbs, approached within the length of its neck: the chewing of this animal was similar to that of a Cat. These external habits of motion, compared with those of the limbs, coincide very much with the internal structure here described.

REFERENCES TO THE FIGURES.

Plate I.

The figure represents a dried preparation of the *Lemur tardigradus*, exhibiting the appearances of the arterial system.

a, the carotid arteries.

b, the axillary artery, dividing into the plexus described.

c, the iliac arteries, dividing into the cylindrical ramifications.

The other parts of the arterial system are represented according to the natural and ordinary disposition.

Plate II.

Fig. 1, shews the axilla of the *Bradypus tridactylus*, dissected to expose the vessels.

a, the sterno mastoideus muscle, passing under the skin of the neck.

b, part of the axillary plexus of nerves; the median proceeding along the arm, with the large blood-vessels, and giving off two branches of communication with the ulnar nerve.

c, the subclavian vein.

d, the first bone of the sternum, attached to its second bone, and to the first and second ribs.

e, the subclavian artery, passing into the axilla behind the large veins, and dividing itself into a great number of equal-sized cylinders, which cling together, frequently anastomose, and take the ordinary route of the main trunks of arteries in the upper limbs of quadrupeds.

Fig. 2, the brim of the pelvis and groin of the *Bradypus tridactylus*, with the vessels exposed.

a, the aorta, where it divides into the two great iliac branches; the iliac artery on the right side being continued, to shew the division into the anastomosing cylinders which are sent to the muscles.

b, part of the iliacus internus muscle.

c, part of the bony margin of the pelvis leading down to the pubes.

Fig. 3, the upper limb of the *Bradypus didactylus*.

a, a portion of skin on the top of the shoulder.

b, the axillary artery, divided more in the ordinary way than in the former animal. This creature had been preserved in ardent spirit containing camphor; and the dissection could not be prosecuted so satisfactorily as to expose every small branch.

c, part of the axillary plexus of nerves.

Fig. 4, the iliac vessels of the *Bradypus didactylus*.

a, the tendon of the psoas muscle.

b, the iliac artery, proceeding into the thigh, where its divisions are more discernible than in the upper limb. The cylindric tubes were however much fewer than in the *Bradypus tridactylus*. I counted only eight tubes in the inguinal fasciculus

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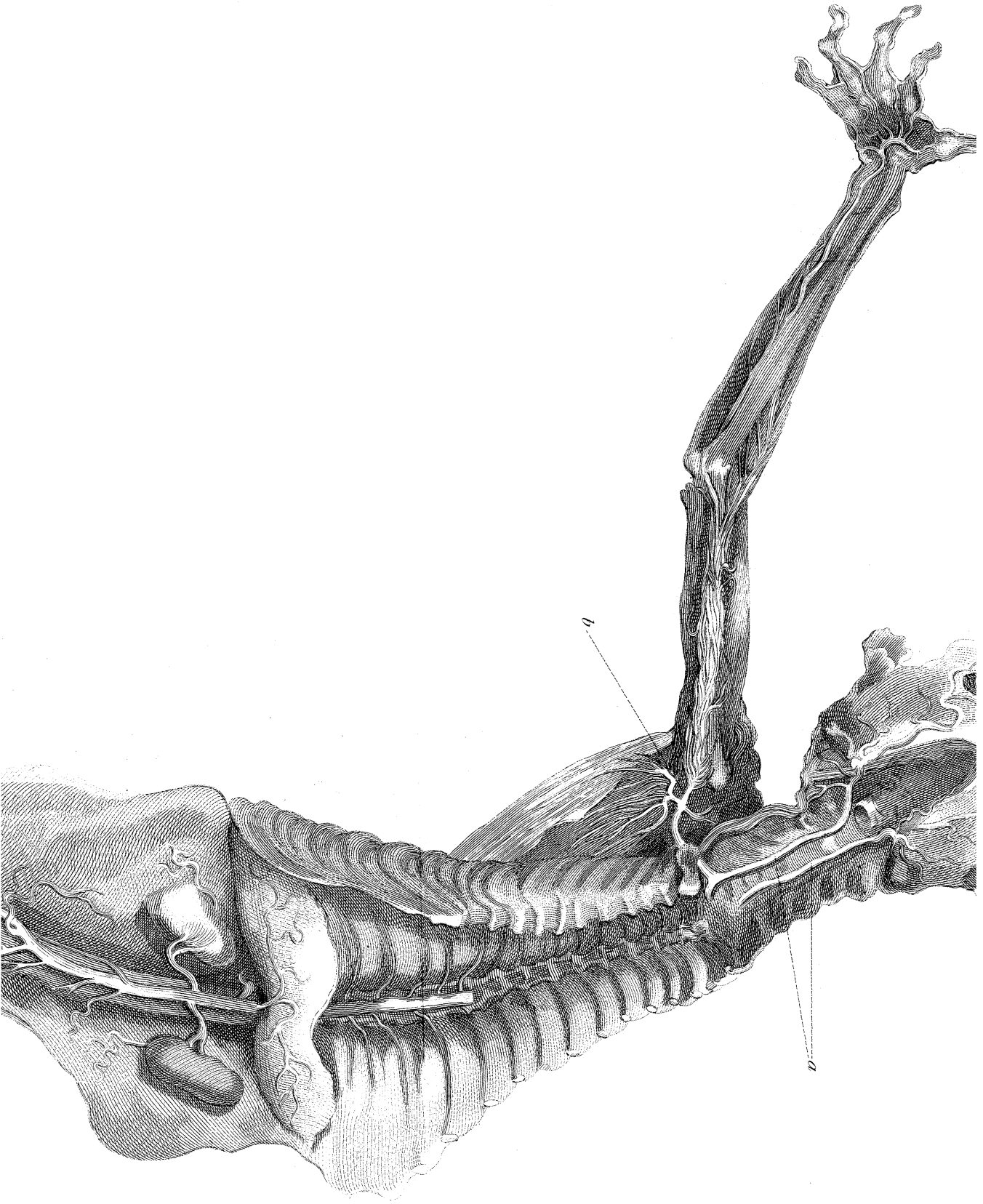
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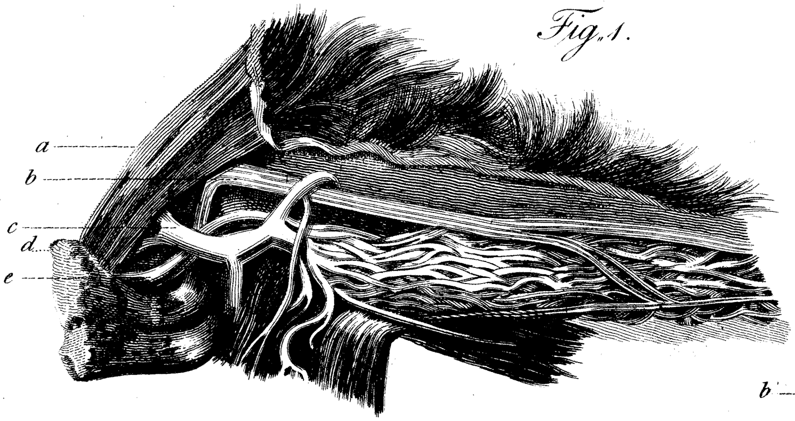

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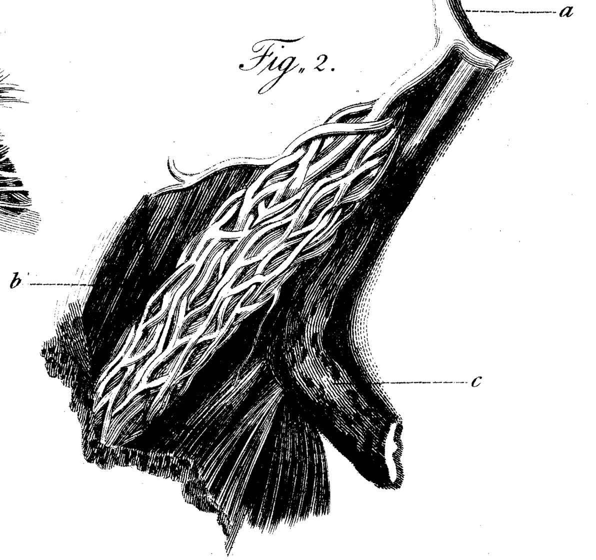

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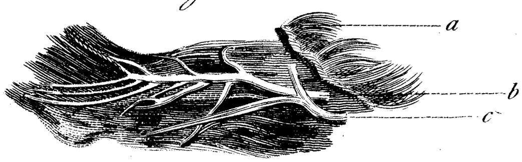

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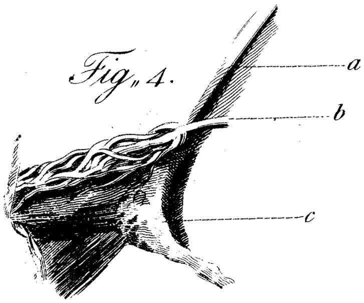

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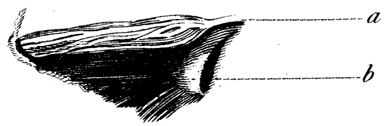

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of this Sloth, whereas in the same part of the *tridactylus* there were at least forty.

c, part of the rim of the pelvis.

Fig. 5, the upper limb of the *Lemur Loris*.

a, the head of the os brachii.

b, the axillary artery, proceeding along the arm, and dividing into seven or eight cylinders.

Fig. 6, the inguinal arteries of the *Lemur Loris*.

a, the iliac artery, dividing as it passes the groin into five or six cylinders.

b, the bony margin of the pelvis.

The figures are of the size of the different natural objects.