Notes on animal mechanics / by Samuel Haughton. No. VII., On the muscular anatomy of the Macacus nemestrinus.

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NOTES

ON ANIMAL MECHANICS.

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[Read before the Royal Irish Academy, June 26, 1865.]

No. VII.—On the Muscular Anatomy of the Macacus nemestrinus.

The first monkey which I shall describe in this Note was a very fine specimen of *Macacus nemestrinus*, which died, after a short illness, in January of the present year, of tubercular disease affecting the liver, spleen, and other organs. He had previously suffered from rheumatic arthritis of both knee joints, which had destroyed the anterior surfaces of the outer condyles of the femur, and so caused dislocation of both patellas outwards.

On examination after death, the following observations were made:—

1. *Lungs*; both filled with miliary tubercle.
2. *Heart*; exhibited two specks of tubercle, similar to those met with in the lungs.
3. *Liver*; divided into five lobes, of which four were filled with tubercular nodules, and the fifth was wholly converted into a cheesy tuberculous mass.
4. *Spleen*; contained several large nodules of softened tubercle.
5. *Glands*; of mesentery, united into one tubercular mass; of thoracic spinal region, somewhat affected; of lumbar region, healthy.

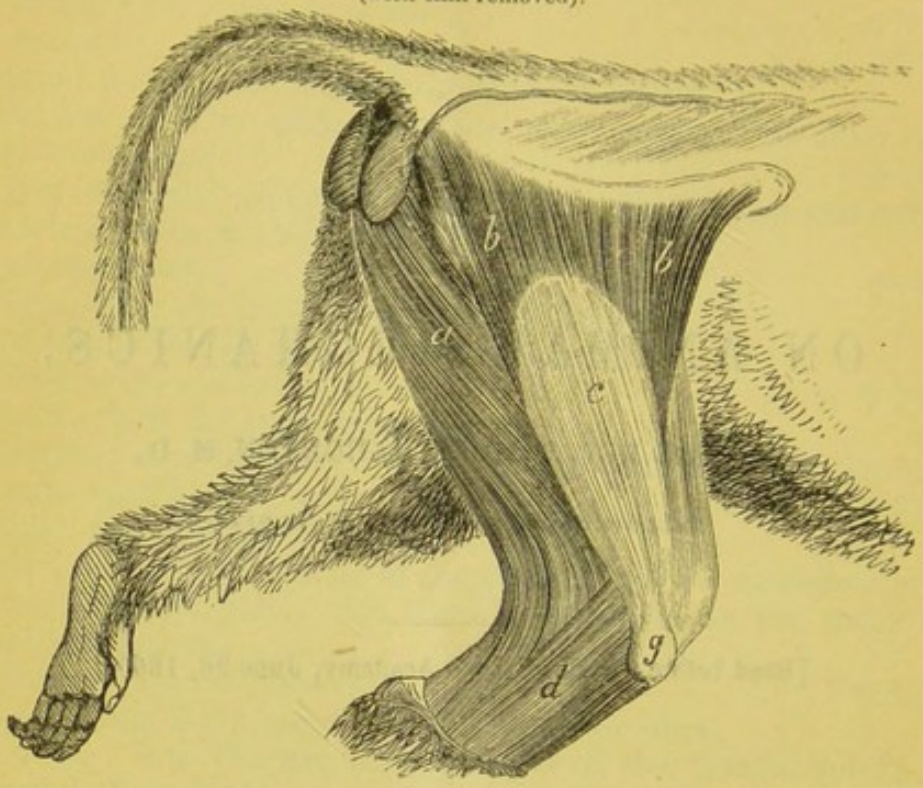
Weight of dead body, ... 26 lbs.

Muscles of Leg and Foot.

1. *MM. agitator caudæ, glutæus maximus, tensor vaginæ femoris* (Fig. 21, *b b*), ... 0·90 oz.

Fig. 21.*

HIND LEG OF MACACUS NEMESTRINUS (with skin removed).



a, *Biceps femoris.*
b b, Combined *agitator caudæ*, *glutæus maximus*, and *tensor vaginæ femoris.*
c, Great fascia of thigh.
d, Outer portion of *gastrocnemius.*
g, Displaced patella of right knee.

These three muscles form one continuous sheet of fibres, expanded over the upper and outer portion of the thigh; they are shown at *b b*, Fig. 21.

The *agitator caudæ* forms the posterior portion of the entire muscle, and takes its origin from the first and second caudal vertebræ; the *tensor vaginæ* corresponds to the *agitator* in front of the muscle, and arises from the crest of the ilium; and the smallest, or central portion, is composed of the *glutæus maximus* proper; this muscle, however, deserves its human name so little in the Macaque, that it is only equal in weight to the *glutæus minimus*, which is 165 grs.

The whole complex muscle is inserted below and behind the great trochanter, and into the whole of the great fascia covering the thigh on the outer side.†

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* This and the following figures were drawn from nature by my son.

† The fibres of this curiously shaped muscle are not parallel, but converge through an angle of 16°, to a point 14⅓ inches from the crest of the ilium; and their resultant

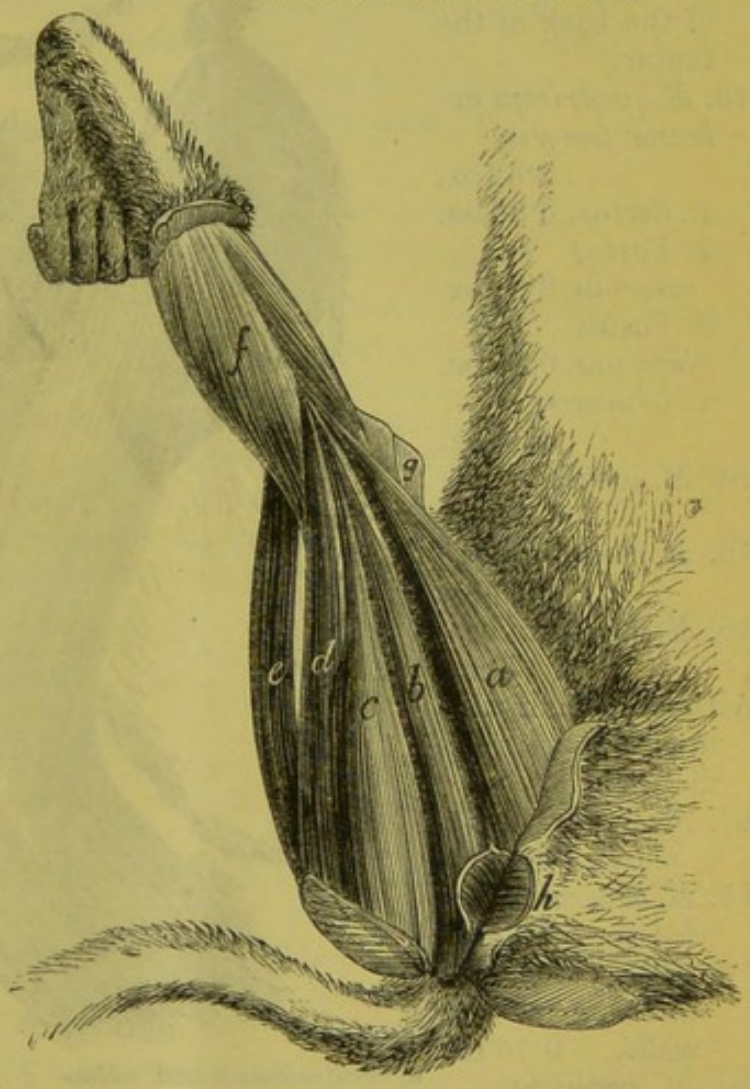
2. *M. glutæus medius*, ... 1·95 oz.
3. *M. glutæus minimus*, ... 0·37 oz.
4. *M. biceps femoris* (Fig. 21, *a*; Fig. 22, *b*; Fig. 23, *e*), . 1·10 oz.
   Inserted into the back of the lower third of the femur, and by fascia down the upper third of the leg; the resultant plane of all its fibres falls below the knee joint.
5. *M. semitendinosus* (Fig. 23, *b*), ... 0·61 oz.

   Takes origin from the *tuber ischii*, and is inserted by a flat tendon into the upper point of trisection of the tibia.
6. *M. semimembranosus* (Fig. 23, *d*), 0·67 oz. Origin; the posterior line of ischium. Insertion; into the top of the tibia by a round tendon.
7. *M. gracilis* (Fig. 23, *a*), . . 0·55 oz. Origin; from the *symphysis pubis*. Insertion; beside the *semimembranosus*, and inside the *sartorius*, into the upper fourth of the tibia.
8. *M. sartorius*, (Fig. 22, *e*), . . 0·32 oz.
9. *M. adductor longus* (Fig. 23, *c*), 0·90 oz. Origin; from the spring of the arch of the pubis. Insertion; into the back of the inner condyle, and one inch up the femur.
10. *M. adductor magnus*, . . 3·20 oz.

Fig. 23.

COMBINATION OF FLEXORS OF THE KNEE JOINT IN THE MACACUS NEMESTRINUS

(viewed from behind, in the lithotomy position),



a, *Gracilis*.
b, *Semitendinosus*.
c, *Adductor longus*.
d, *Semimembranosus*.
e, *Biceps femoris*.
f, *Gastrocnemius*.
g, Dislocated patella.
h, Bulb of urethra.

divides the base line joining the crest of the ilium with the second caudal vertebra in the proportion of 31 to 36.

Origin; fleshy, from the symphysis and arch of the pubis.
Insertion; into the entire length of the back of the femur.

11. *M. adductor brevis*, ... 0·37 oz.
Origin; from the top of the symphysis pubis.
Insertion; into the second upper fourth of the back of the femur.

12. *M. pectinæus*, 0·22 oz.
Origin; from the pectinæal line.
Insertion; into the upper fourth of the back of the femur.

13. *M. quadriceps extensor femoris*, 2·32 oz.
1. *Rectus*, 0·80 oz.
2. *Vastus externus*, 0·82 oz.
3. *Vastus internus*, 0·40 oz.
4. *Cruræus*, 0·30 oz.

14. *M. psoadiliacus*, 1·87 oz.

15. *M. psoas parvus*, 0·27 oz.

16. *M. iliocapsularis*, 5 grs.
Although small, this muscle was very distinct.

17. *M. quadratus femoris*, 0·46 oz.

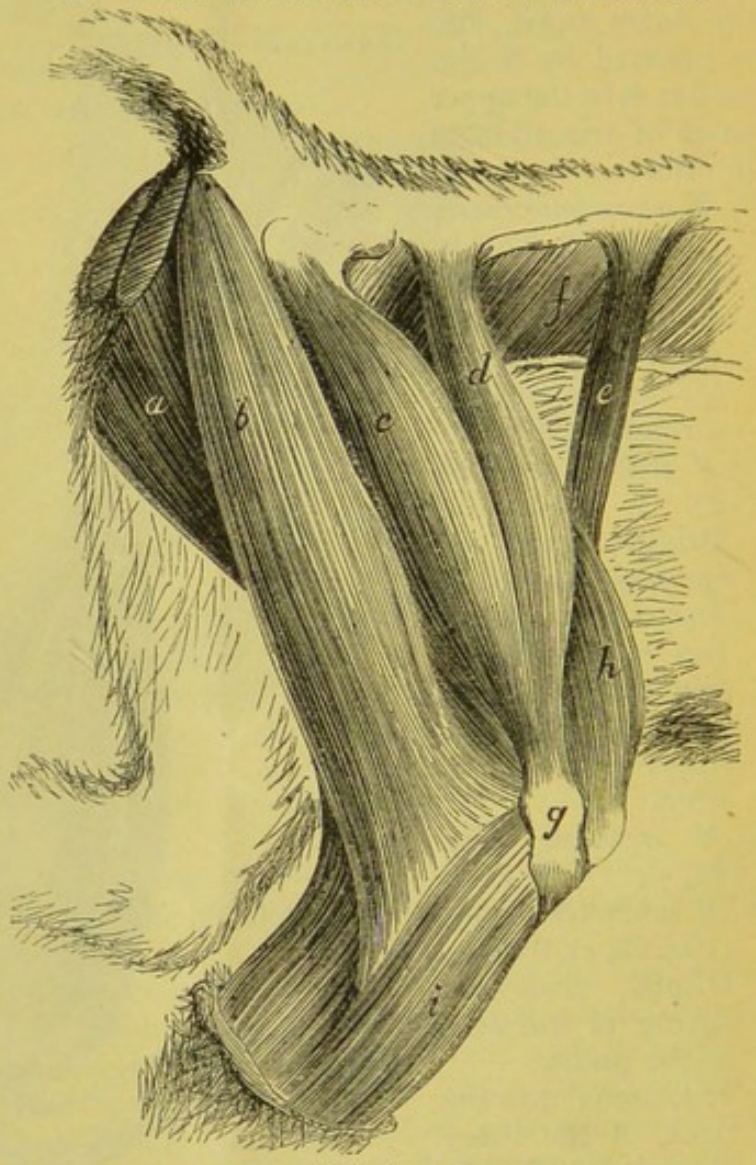
18. *M. obturator externus*, 0·53 oz.

19. *MM. obturator internus et gemelli*, 0·75 oz.

20. *M. poplitæus*, 0·06 oz.
An interesting observation may be made upon the muscles that act upon the knee joint: that they do not all act in the plane of motion of the joint itself, but at the same time their actions are so balanced, that their total resultant is, in all probability, ac-

Fig. 22.

DEEP MUSCLES OF RIGHT LEG OF MACACUS NEMESTRINUS.



a, *Semitendinosus* and *adductor longus*.
b, *Biceps femoris*.
c, *Vastus externus*.
d, *Rectus femoris*.
e, *Sartorius*.
f, *Psoadiliacus*.
g, Dislocated patella.
h, *Vastus internus*.
i, Outer portion of *gastrocnemius*.

curately in that plane; this indeed is a result to be expected in a hinge joint like the knee, for otherwise there would be a constant wrench produced on the joint, by the unbalanced rotation outwards or inwards.

Of the muscles that flex the knee joint, the *biceps*, *semimembranosus*, and *sartorius* were found to act in the plane of the joint, while the *semitendinosus* abducted at an angle of 5° 40′, and the *gracilis* adducted at an angle of 8°.

A little consideration will serve to show, provided my postulates be admitted, that the *semitendinosus* wrenches the joint by a rotation *inwards*, represented by its weight multiplied by the sine of the angle its plane makes with the plane of motion of the knee joint; and that the *gracilis* wrenches the joint by a rotation *outwards*, represented by a similar quantity.

Hence we find

Wrenching moment *inwards* of *semitendinosus* = 0·61 × sin 5° 40′ = 0·06 oz.
,, *outwards* of *gracilis* = 0·55 × sin 8° = 0·07 oz.

These two wrenching moments nearly balance each other, so as to leave little or no strain on the joint; and it is probable that the slight difference between them is compensated by the action of the *poplitæus*, which aids the *semitendinosus* to some extent.

The flexors of the leg are well shown in Fig. 23, which represents them all in their natural positions, with the exception of the *biceps*, which has been drawn out of its place, in order to show better the position of the remaining muscles.

21. *M. gastrocnemius*, ... 0·89 oz.
22. *M. solæus*, ... 0·63 oz.
23. *M. plantaris*, ... 0·18 oz.
24. *M. flexor digitorum longus*, ... 0·36 oz.
25. *M. tibialis posticus*, ... 0·30 oz.
26. *M. flexor hallucis longus*, ... 0·66 oz.
27. *M. accessorius*, ... 0·05 oz.

The tendon of the *flexor hallucis* divides, in the centre of the sole, into tendons distributed to the 3rd and 4th toes, and another tendon which constitutes half the tendon of the hallux.

The tendon of the *flexor digitorum* divides at the same point into tendons distributed to the 2nd and 5th toes, and another tendon which constitutes the remaining half of the tendon of the hallux.

The *M. accessorius* tendon meets all the foregoing at the point of subdivision; but its largest branch is continued directly on, into the tendon of the *flexor hallucis*.

The distribution of the flexor tendons to the toes varies in different genera of Monkeys.

In the *Cebus*, their distribution is like that of the *Macacus nemestrinus*, viz., *flexor hallucis* to 3rd, 4th, and half the hallux;

and *flexor digitorum* to the 2nd, 5th, and half the hallux; and they all anastomose together in the sole of the foot, where they are joined by the *accessorius*.

In the *Cercopithecus fuliginosus* (Cuvier), or Sooty Mangaby, with white eyelid, the *flexor digitorum* supplies the tendons of the 2nd and 5th toes, and one-third of the tendon of the hallux; the *flexor hallucis* supplies the tendons of the 3rd and 4th toes, and two-thirds of the tendon of the hallux; and there is no *accessorius* muscle.

In the *Hapale*, the *flexor hallucis* supplies the 3rd and 4th toes only, so that its human name becomes inappropriate; and the *flexor digitorum* supplies the 2nd and 5th toes, with a small slip to the hallux.

In the *Lagothrix* the *accessorius* muscle is wanting, and the *flexor hallucis* is distributed to the 2nd, 3rd, and 4th toes, and partly to the hallux, while the *flexor digitorum* supplies the 4th and 5th toes, and partly the hallux.

In the *Chimpanzee*, the *flexor hallucis* supplies the whole tendon of the hallux (to which one-third of its force is sent), one-third of the tendon of the 2nd toe, two-thirds of that of the 3rd toe, and the whole of the 4th toe; while the *flexor digitorum* supplies two-thirds of the tendon of the 2nd toe, one-third of that of the 3rd toe, and the whole of the 5th. There is no *accessorius*.

In *Man*, the *flexor hallucis* supplies the whole tendon of the hallux, and half that of the 2nd toe (two-thirds of its force going to the hallux, and one-third to the 2nd toe); and the *flexor digitorum* supplies the remaining half of the tendon of the 2nd toe, and the whole tendons of the 3rd, 4th, and 5th toes; and the *accessorius* combines the two tendons together in the sole of the foot, pulling on both.

The different mechanical uses of the foot, indicated by these various arrangements, would form a most interesting study for an anatomist, who might have the opportunity of observing the animals during life, with their varied habits of grasping, climbing, and walking.

28. *M. peronæus longus*, ... 0·32 oz.
29. *M. peronæus brevis*, ... 0·24 oz.
30. *M. tibialis anticus*, ... 0·79 oz.

This muscle is composed of two distinct portions, inserted respectively into the cuneiform bone and into the metatarsal of the hallux.

Cuneiform portion, ... 0·56 oz.
Metatarsal portion, ... 0·23 oz.

31. *M. extensor digitorum communis*, ... 0·27 oz.
32. *M. extensor proprius hallucis*, ... 0·12 oz.
33. *M. extensor digitorum brevis*, ... 0·10 oz.
34. *MM. abductor et opponens hallucis*, ... 0·08 oz.

35. *M. flexor digitorum brevis* (*perforatus*), ... 0·08 oz.

This muscle is divided into two parts:—

1. *Flexor indicis perforatus*, having the human origin.
2. *Flexor digitorum*; having an origin from the *flexor digitorum longus* tendon, to which it is an accessory muscle.

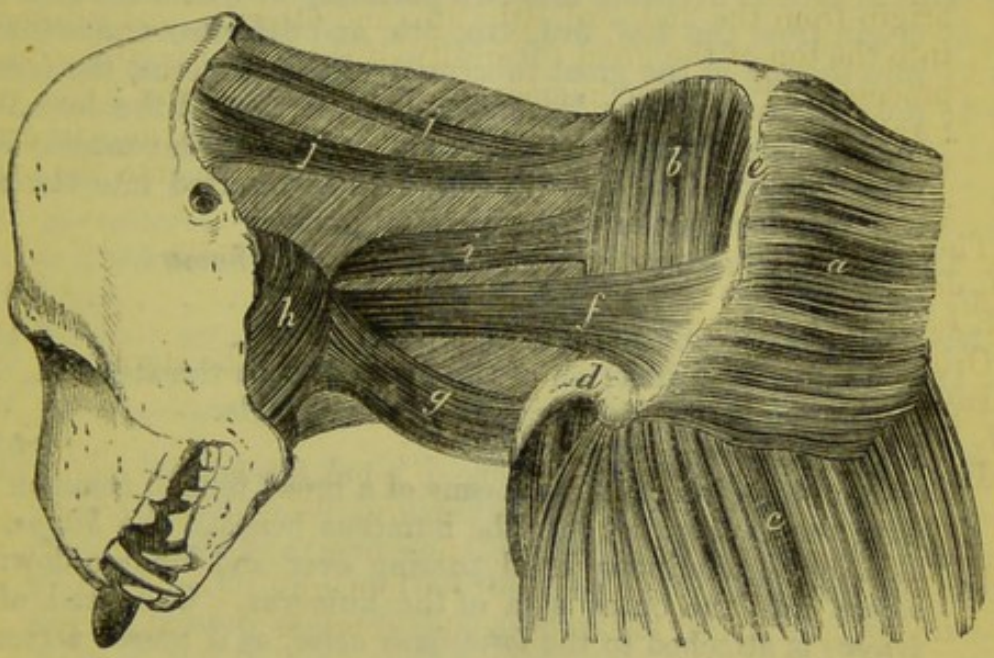
36. *M. abductor minimi digiti*, ... 0·04 oz.
37. *M. flexer hallucis brevis*, ... 0·07 oz.
38. *M. adductor hallucis*, ... 0·22 oz.

Muscles of Arm and Hand.

1. *M. trapezius*, ... 1·50 oz.
2. *M. omo-atlanticus* (Fig. 24, *f*), ... 0·31 oz.

Fig. 24.

MACACUS NEMESTRINUS.



a, *Trapezius*, reflected.
b, *Supraspinatus*.
c, *Deltoideus*.
d, Clavicle.
e, Spine of scapula.
f, *Omo-atlanticus*.
g, *Sternomastoideus*.
h, *Massetericus*.
i, Accessory atlantic slip of *serratus magnus*.
jj, Accessory occipital slips of *rhomboideus*.

Origin; from the transverse process of the atlas.
Insertion; into the anterior third of spine of scapula.

The insertion of the omo-atlantic muscle in the *Macacus nemestrinus* forms an exception to its usual insertion in the smaller Macaques, in which it is attached to the third of both the clavicle and spine of the scapula nearest the shoulder joint. Its insertion in the *M. nemestrinus* is like that of the Cercopitheci. In *Cynocephalus porcarius* and *C. maimon* it is inserted into the outer third of the spine of the scapula only. This muscle is wanting in the Cebus.

3. *M. rhomboideus* (*vide* Fig. 24, *jj*), ... 0·70 oz.
   Origin; from the spinous processes of the upper half of the dorsal vertebræ, all the cervical, with *two* accessory slips from the occipital ridge, shown at *jj*, Fig. 24.
   Insertion; into the vertebral edge of the scapula.
   One or more of these accessory slips of the rhomboid muscle are present in most of the Macaques and Cercopitheci, and Cynocephali; they are to be regarded as portions of the rhomboid, with origin extended to the head, and are connected with motions of the head and shruggings of the shoulder, essentially ape-like, and not human. The accessory slip of the Rhomboid muscle is wanting in the Cebus.
4. *M. sternomastoideus* (Fig. 24, *g*), ... 0·61 oz.
5. *M. pectoralis major*, ... 1·62 oz.
6. *M. pectoralis minor*, ... 0·83 oz.
   This muscle is divisible into two portions, of which the first takes origin from the 2nd, 3rd, 4th, 5th, and 6th ribs, and is inserted into the top of the great tuberosity of the humerus, the coracoid process, and capsular ligament; this portion of the lesser pectoral weighs 0·57 oz.; the second portion of the muscle arises from the 6th, 7th, and 8th ribs, and is inserted into the upper and anterior margin of the bicipital groove.
   The first portion may be regarded as a *levator humeri*.
7. *M. deltoideus*, ... 1·37 oz.
8. *M. subclavius* (second pectoral of birds?) . . . . . 0·13 oz.
   Origin; from the junction of the first rib with the sternum.
   Insertion; into the inferior edge of the clavicle.
9. *M. latissimus dorsi*, ... 2·57 oz.
   This muscle is inserted, by means of a broad tendon common to it with the *teres major*, into the humerus beneath the *biceps*, and also by a tendinous band passing over and binding down the *biceps*, into the outer side of the humerus. One head of the *triceps* is attached to the *latissimus dorsi*, as it passes across the axilla.
10. *M. serratus magnus* (*vide* Fig. 24, *i*), ... 1·66 oz.
    In this muscle I have included the *levator anguli scapulæ*, which cannot be separated from it as a distinct muscle, and also the distinct slip figured at *i* (Fig. 24), which takes its origin from the posterior tubercle of the transverse process of the atlas.
11. *M. supraspinatus* (Fig. 24, *b*), ... 0·85 oz.
12. *M. infraspinatus*, ... 1·07 oz.
13. *M. triceps*, ... 3·33 oz.
    This muscle has four heads—
    1. From the *latissimus dorsi*.
    2. From the anterior half of the lower edge of the scapula.
    3, 4. Double origin, fleshy, from the back of the humerus, as in Man.

14. *M. teres major*, ... 0·80 oz.
Origin; from the posterior inferior angle of the scapula.
Insertion; with the *latissimus dorsi*, by means of a broad tendon, of which the *teres* forms two-thirds, and the *latissimus* one-third.
15. *M. teres minor*, ... 0·15 oz.
16. *M. subscapularis*, ... 1·45 oz.
17. *M. biceps humeri*, ... 1·57 oz.
18. *M. coracobrachialis*, ... 0·12 oz.
This muscle is intimately blended with the coracoid head of the *biceps*.
19. *M. brachialis anticus*, ... 0·47 oz.
20. *M. pronator radii teres*, ... 0·32 oz.
21. *M. flexor carpi radialis*, ... 0·37 oz.
22. *M. palmaris longus*, ... 0·18 oz.
23. *M. flexor sublimis digitorum*, ... 0·77 oz.
24. *M. flexor carpi ulnaris*, ... 0·73 oz.
25. *M. supinator radii longus*, ... 0·77 oz.
26. *M. extensor carpi radialis longior*, ... 0·33 oz.
27. *M. extensor carpi radialis brevior*, ... 0·32 oz.
28. *M. extensor digitorum communis*, ... 0·34 oz.
29. *M. auricularis*, ... 0·08 oz.
This little muscle sends a tendon to the 4th as well as to the 5th finger.
30. *M. extensor carpi ulnaris*, ... 0·28 oz.
31. *M. flexor digitorum profundis*, } . . . . . 1·95 oz.
M. flexor pollicis longus, }

There is no distinct *flexor pollicis longus;* but a tendon branches off to the thumb, from the central portion of the tendon of the *flexor digitorum profundus*, that supplies the 3rd and 4th fingers. I found by trial that the weights of equal lengths of the thumb tendon and common tendon to the other four fingers were as 116 to 243; showing that one-third of the whole force of the muscle is expended on the thumb, and the remaining two-thirds on the other fingers—for it is easy to see that the forces acting along the subdivided tendons must be exactly proportional to their strengths as measured by the weights of equal lengths.

The peculiarities of the human *flexor pollicis longus* have always been insisted upon by anatomists as essentially characteristic of Man, as distinguished from the Quadrumans; but exceptions of the most startling kind are occasionally met with. While I was engaged in the dissection of the *Macacus nemestrinus*, I called the attention of Mr. Finney, Medical Scholar of Trinity College, to the arrangement of the tendons of the deep flexor, who then mentioned to me the case of a male subject dissected

by him in November, 1864. On referring to his note book, I was able to extract the following observation :—

" Abnormal *flexor pollicis longus*.—The fleshy origin of this muscle from the bone of the forearm was entirely wanting, and the tendon of the *flexor pollicis longus* was attached opposite to the base of the 3rd metacarpal bone, to the tendons of the *flexor digitorum profundus*, on their superficial surface."

This remarkable example shows that Man may sometimes possess the arrangement of tendons of thumb and fingers characteristic of the Macaque; but whether such a case should be regarded as a Macaque passing upwards into a Man, or a Man passing downwards into a Macaque, or as a congenital freak of nature, I cannot undertake to say.

In the *Cercopithecus fuliginosus* (Cuvier), the tendon of the *flexor pollicis longus* springs, as in the Macaque, from the central portion of the tendon of the *flexor profundus* that supplies the middle and ring fingers.

In the Cebus and Lagothrix, a more degraded type of thumb is found; for the *flexor pollicis longus* is represented by a tendon to the thumb, not proceeding from the central portion of the tendon of the *flexor profundus*, but by a tendon which is merely one of the five tendons into which the *flexor profundus* is divided in the lower animals.

It is remarkable, however, that among the Quadrumans the most degraded type of thumb is to be found in the so-called Anthropoid Chimpanzee, for an opportunity of dissecting which, as well as the Negro Monkey, I am indebted to the kindness of Mr. Thomas J. Moore, Curator of the Derby Museum, of Liverpool. In the Chimpanzee, the tendon of the *flexor pollicis longus* is formed by the union of two small thread-like tendons; of which one, of silky texture, is derived from the muscle of the *flexor sublimis* (*perforatus*), of the index finger; and the other, equally slender, but wanting the silky lustre, proceeds from the tendon of the *flexor sublimis* of the little finger.*

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* The following remarks on this curious subject, by Professor Gratiolet, will be read with interest by anatomists:—

" The anatomical examination of this Chimpanzee (*Troglodytes Aubryi*) reveals profound and really typical differences between man and the most elevated apes. In the latter the thumb is bent by an oblique division of the common tendon of the muscle which bends the other fingers; it is, therefore, influenced by the common movements of flexion, and therefore is not free. This type is realized in the Gorilla and Chimpanzee; but the small tendon which moves the thumb is in these reduced to a tendinous thread, which exerts no action, for its origin is lost in the synovial folds of the tendons which bend the other fingers, and it abuts on no muscle; the thumb, therefore, in these apes is wonderfully enfeebled. In none of them is there a trace of the large independent muscle which gives movement to the human thumb. Far from becoming more strongly deve-

32. *M. pronator quadratus*, ... 0·10 oz
33. *M. supinator radii brevis*, ... 0·22 oz.
34. *M. extensor ossis metacarpi pollicis*, ... 0·25 oz.
35. *M. extensor primi internodii pollicis*, } united, . . 0·05 oz.
    M. extensor secundi internodii pollicis, }
36. *M. indicator*, ... 0·05 oz.
    This muscle sends a tendon to the middle finger, as well as to the index.
37. *M. abductor pollicis*, ... 0·05 oz.
38. *M. opponens pollicis*, ... 0·03 oz.
39. *M. flexor pollicis brevis*, ... 0·11 oz.
40. *M. adductor pollicis*, ... 0·03 oz.

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loped, the member so characteristic of the human hand seems in the most elevated apes (the Orangs) to incline to a complete annihilation. These apes, therefore, have nothing in the organization of their hand which indicates a passage into the human form; and I insist in my memoir on the profound differences revealed by the study of the movements in hands formed to accomplish objects of a totally distinct order. A close examination of the muscles of the arm and shoulder in the pretended anthropomorphous apes confirms these results. Besides, it is especially in the ape in appearance the most like man—the Indian Orang—that the hand and foot present the most striking degradations. This paradox—this default in the parallelism in man and the large apes in the developement of correlative organs, such as the brain and the hand—shows absolutely that other harmonies and other destinies are here in question.

"The facts upon which I insist permit me to affirm, with a conviction founded on a personal and attentive study of all at present known, that anatomy gives no grounds for the idea, so violently defended now-a-days, of a close relationship between man and ape. One may invoke in vain some ancient skulls, evident monstrosities, found by chance, such as that of Neanderthal—and here and there similar forms may now be found; they belong to idiots. One of these was discovered a few years ago by Dr. Binder, who, at the request of M. Macé, presented it to me. It is now in the collection belonging to the Museum. It will henceforth be counted among the elements of the great discussion on the nature of man which now agitates philosophers and troubles consciences; out of which discussion, some day, the divine majesty of man shall arise consecrated by combat, and ever henceforth be inviolable and triumphant."